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NEW YORK, FEBRUARY, 1889.

IN spite of the continued extension of the use of iron and steel in bridges and other structures, wood must continue to play a very important part in our railroads and other engineering works. Wooden trestles and wooden bridges will continue very largely in use until timber becomes very much scarcer and more expensive in this country than it now is, while on highway roads the great majority of the smaller bridges will continue to be of wood for many years to come. Culverts, cattle-guards, and other structures of wood, aside from bridges, are and will remain in extensive use, and every engineer in active service knows how necessary a knowledge of the principles governing such structures is to the proper performance of his duties. In too many cases the wood-work on our railroads is considered a mere carpenter's job, and is left to be worked out by rule of thumb, or by following old and often faulty precedents, either because the engineer has not time to attend to it, or because he has not the necessary instruction.

Under these circumstances it is believed that the series of articles begun in another column on Wooden Structures will be both of interest and value to engineers and others. Their object is not so much to present anything absolutely new as to formulate and make accessible the most approved practice with regard to such structures, and the principles which should govern generally the use of wood in engineering. They will be fully illustrated as the subject requires, and accompanied by definite and practical directions as well as by full descriptions.

THE subject of highway roads is attracting some attention just now, and in two States—New Jersey and Pennsylvania—the Governors have called legislative attention to the necessity of improvement. In most of our States the regulation of roads has been left to towns and local authorities, and has been in very incompetent hands, so that the work done on them has been either neglected or in a large part wasted. The favorite plan at present seems to be a change of control from township to county authorities, giving the road superintendent a wider field to work in, and an opportunity to adopt comprehensive plans; also permitting the employment of more competent persons as overseers.

A step which promises good results has been taken by Vanderbilt University, at Nashville, Tenn., where the Engineering Department has offered to admit free of charge to its class in road engineering, one highway officer from each county in the State. The course of instruction, which is given in the winter months, consists of lectures and work on the location of roads; the principles of construction and maintenance; methods of drainage and similar matters, and is intended to be as practical as possible. This is a move in the right direction, and if the County Board and local officers can be persuaded to co-operate will doubtless produce excellent results.

THE Poughkeepsie Bridge is now very nearly completed, and the first train passed over it December 29. The bridge proper and its approaches can be made ready for regular traffic in a very few days, and it now only waits the completion of its connecting lines to come into full use. The line west of the river has still two or three months' work to be done upon it. East of the river one connection is already made, but there is still a great deal of work to be done on the line to Brewsters, from which most of the bridge traffic is expected to come. It will probably be summer before the bridge can be considered as full opened.

ANOTHER notable bridge structure now nearly completed is the new Manhattan Bridge over the Harlem River in the upper part of New York City. This is a road or street bridge crossing the deep valley through which the river flows at that point on two steel arches of 525 ft. span, the approaches on each side consisting of stone arched viaducts. It is a very handsome structure, and rivals in appearance the famous High Bridge a short distance from it.

THE output of steel rails in 1888 fell off nearly one-third from those of 1887, the total reported last year having been 1,528,057 tons against 2,290,197 in 1887. It must be remembered, however, that 1887 was an exceptionally prosperous year, when some 13,000 miles of new railroad were built, or almost twice as much as last year. The difference in new construction will account for the falling off in sales, and it is probable that the regular demand for renewals was fully as great, if not greater last year than in 1887. This is, after all, the demand upon which the mills have to rely for a steady business, and that it should be well kept up is an encouraging feature of the trade.

NEW railroad construction in 1888, as reported by the *Railway Age*, amounted to 7,120 miles, or a little over one-half that of 1887, a result somewhat greater than might have been anticipated from the course of events early in the year. A considerable part of the work done was on lines begun in 1887, and in completion of systems marked out in that year, and a very large proportion of it was done by old companies. The total number of lines or branches on which track was laid was 365. A large num-

ber of these were short, very few long roads or extensions being included in the list, and hardly any which can be considered as through or trunk lines.

The Southern States led in the increase, reporting 2,074 miles, or nearly 30 per cent. of the total. The Southwest followed, with 1,675 miles, or about 23 per cent. The Pacific Coast, with 1,055 miles, and the Central Western States (Ohio to Illinois, inclusive), with 1,030 miles, were nearly even, while the Northwest reports only 834 miles, the Middle States, 270, and New England, 182 miles. The greatest mileage built in any one State was 601 miles in Kansas, California coming second with 560, Georgia third with 452, and Kentucky fourth with 353 miles.

It is notable that the building of new through lines, and especially of competing lines, which stopped some time ago in the East, has almost come to an end in the Northwest. A good deal of this kind of work was done in the Southwest last year, but mainly in the execution of plans already made, and it is safe to say that still less will be done this year by the companies which are now suffering from the results of over-competition.

The new work in the South has been of an excellent kind, chiefly of short lines intended to develop local business. Very much of it has been done with special reference to the mineral resources of that section, which are now attracting so much attention.

The present prospects are that while 1889 will be rather an off year for new railroad construction, there will be a fair amount built, chiefly in short local lines and branches.

THE latest attempt to counteract the losses and evils resulting from over-building and over-competition has taken the form of an agreement adopted at a meeting, at which were present a large number of railroad officers and bankers interested in railroads. At this meeting a plan of organization was adopted for an Interstate Commerce Railroad Association, the object of which is the regulation of rates; the prevention of undue competition; the enforcement of the Interstate Commerce Law, and the settlement of disputes by arbitration. The agreement has many excellent points, and should produce a good effect. It has, however, the same drawback which has attended all previous agreements, and that is, that there is no possible method of enforcing its observance, and that it depends entirely upon the good faith of the railroad officers, who are the contracting parties.

Unfortunately, past experience shows that this is a very doubtful guarantee, and that, however high the individual character of a railroad officer may be, his corporate action is not to be relied upon. A reform in this respect is most urgently needed, and it is to be hoped that the new agreement may be a beginning in this direction.

THE New York Railroad Commission has submitted its annual recommendations to the Legislature in the form of 10 bills, which have been presented in the Senate. The first gives the Commission power to enforce its recommendations by an appeal to the Supreme Court. The second provides for the gradual abolition of highway-grade crossings. The third is a general law regulating the leasing of roads. The fourth prohibits the leasing of parallel or competing lines. The fifth prohibits rebates or discrimination in rates. The sixth bill imposes a fine for failure to make annual reports. The seventh specifies the limit and degree of liability for fire resulting from locomotive sparks, on property adjoining a railroad line. The eighth requires railroad companies to place railings on the sides of every freight car, while the ninth provides for the substitution of some approved form of rail for the center-bearing rail now in use on street railroads.

These are all renewals of recommendations made to the Legislature last year; the only new bill which the Commission presents is the tenth, which requires railroad companies to place a thermometer in every passenger car, and to maintain the temperature of each car at at least 70 degrees. The Legislature has not heretofore paid very much attention to the recommendations of the Commission, its bills having gone over year after year without action, probably because they have had no special political backing. It is to be hoped that some of them at least will receive this year the attention which they deserve.

THE bill to incorporate the Maritime Canal Company of Nicaragua has passed the House of Representatives, but its opponents succeeded in securing the adoption of several amendments, so that it has to go back to the Senate, where it originated, and its final form will probably be settled by a conference committee. There is no reason why it should not pass, and the only cause for its failure will be the hurry which always marks the end of a short session of Congress. The principal amendments made were intended to prevent any possible application of the Company for a guarantee of its securities by the Government, but this should make little difference, as we do not understand that any such action is or was contemplated.

Meantime it is understood that this delay will not cause any trouble, as, under its present organization, the Company has made provisions for continuing preliminary work on the Canal, and for the commencement of actual construction within the time required by the Nicaragua concession. The present prospects are very good for commencement of actual work, and for the completion of the Canal within a reasonable time.

THE Secretary of the Navy has issued an order directing that the Naval War College be discontinued as a separate institution, and consolidated with the Torpedo School. This order will require a considerable change in the plans for carrying on the College, but does not, it is understood, imply the entire discontinuance of the very useful course of instruction which it was intended to furnish.

ELECTRICITY plays an important part in the modern war vessel; not only is it used for lighting, but it is now also applied in several ingenious forms for firing guns and for determining the range and direction of the shots. The latest application is in the use of an electric motor for hoisting shot and shell from the magazine below to the level of the guns, and for loading the guns themselves. This apparatus is the invention of Lieutenant Bradley A. Fiske, and is so arranged as to prevent any possible accident resulting from the wounding or death of the gunner. This provides for all contingencies, besides reducing the number of men required to handle a large gun; a very important point where guns are mounted, as is the case in most armored ships, in turrets or barbettes where the space is very limited.

THE recent change in the Russian Ministry of Railroads is, apparently, to be followed by the adoption of an active policy of improvement and extension. The first signs of this will be a large increase in the equipment of the Government railroads, and already orders have been given out for 90 new locomotives, which are to be built in Russia, while it is announced that 230 more are shortly to be ordered. It is also stated that the Russian railroad system is to be improved and extended by the building of several important branches and connecting lines, surveys for which were made some time ago, but whose construction has been postponed from time to time.

It is understood also that a part of the new policy is the active beginning of construction on the Siberian Pacific Railroad, of which mention has already been made in our columns, and which is likely to be an important line from a commercial point of view. In fact, nearly all the new lines projected will be of importance commercially, as most of them are intended to give increased facilities of transportation to the wheat-growing districts and to enable them to compete more actively with those of other countries in the European market. Possibly the Russian Government has been led to adopt this policy from the fact that the British Government is now engaged in carrying out a similar plan for the development of the wheat districts of India, so that that country is every year becoming a more formidable competitor of Russia—and of the United States also—in the grain markets of Europe.

A considerable sum is to be devoted to the improvement and extension of the Trans-Caspian Line. Those sections of the road which were at first slightly built are to be placed on a more permanent basis, the equipment is to be increased, the road is to be extended, and some branches built. On the Western end also the line will probably be extended from its present terminus at Azoun-Ada some 60 miles to Krasnovodsk, which is one of the best harbors on the Caspian Sea. All this indicates that it is the purpose of the Government to develop this road as a commercial line and to abandon the exclusively military character which it at first possessed.

FRANCE is not a country of large navigable rivers, but nevertheless its inland traffic by river and canal is of considerable importance. By the returns made to the Government for 1887 the total length of inland navigation was 16,644 kilometers, of which 12,720 kilometers were reported as much frequented. This length was made up as follows: Rivers floating only small boats, 1,012 kilometers; rivers naturally navigable, 3,340; rivers made navigable by artificial means (canalized), 3,579; canals, 4,789 kilometers. Since 1879 the length of navigable waters has been increased about 2,100 kilometers. Upon these waters there were employed last year 673 steamboats, the greater part being tugs, with a total tonnage of 45,865 tons, and 15,730 boats or barges with a total carrying capacity of 2,714,000 tons. The inland water-courses of France are thus of considerable importance to commerce, and although little is usually heard about them, they are valuable both as auxiliaries to and contemporaries of the railroads. While they do not compare in size or importance with our own internal water-ways, they are still an indispensable part of the traffic system of the country, and the Government wisely takes an active interest in their preservation and extension.

THE work on the ship canal which is intended to connect the Baltic with the North Sea, and which was begun at Kiel in June of last year, is now well advanced, the excavation having been completed for nearly 28 out of the 62 miles required. On the western end the new canal is finished to the junction with the old Eider Canal, and on the eastern or Baltic end about 13 miles are finished. This canal is entirely on German territory, and, like most German Government works, was undertaken largely with reference to its value in case of war, as it will furnish a connection between the German navy-yards and the naval stations on the Baltic and the North Sea, which can be defended without difficulty, and will enable German war vessels to avoid the stormy passage around Denmark and possibly conflict with a hostile fleet under unfavorable circumstances.

While this canal will be useful for commercial as well as for military purposes, it is proposed to make another one entirely on Danish territory, in order to be beyond German control. This canal will be some distance to the north of the German canal, crossing the peninsula of Jutland from the Bay of Jammer to the Limfjord. Surveys have been made for it, and the cost is estimated at about $40,000,000. It is said that the necessary capital has been subscribed by French and English parties, but this seems to be somewhat doubtful.

THE reports of the New York City railroads to the State Railroad Commission give the figures for their traffic for the year ending September 30 last, and enable us to make some comparisons with the previous year. The total number of passengers carried by the elevated roads and by the surface (horse) roads for the year was:

	1888.	1887.
Elevated lines	171,529,789	158,963,232
Surface lines	205,383,797	199,574,966
Total	376,913,586	358,538,198

The increase last year was thus 18,375,388, or a little over 5 per cent.—a decided falling off in the rate of gain from the preceding year, 1887 having shown an increase of 11¼ per cent over 1886. The increase last year on the elevated lines was nearly 8 per cent., showing that those lines have received the benefit of nearly all the new travel, and that the movement of population far up-town continues, though in a somewhat diminished degree.

The gain on the surface railroads was nearly 3 per cent., but an examination of the figures in detail shows that this was due entirely to a remarkable increase on the cross-town lines. Nearly all the up-and-down-town lines, which come into competition with the elevated roads, show slight decreases in traffic.

The equipment of the elevated roads consisted of 291 locomotives and 921 cars, an average of 3.16 cars per engine. The surface roads report 2,133 cars and 13,586 horses—an average of 6.37 horses per car, without making allowance for the one cable road in operation, which would not materially change the average.

The number of accidents was small, the casualties including 27 persons killed and 187 injured. Of these 19 were killed and 140 hurt on the surface roads, mainly by being run over; the remainder, 8 killed and 47 injured, were on the elevated roads. The number of casualties was small in itself, and was considerably less than in 1887.

RAPID TRANSIT IN NEW YORK.

THE people and the papers in New York City are again in their annual paroxysm about rapid transit. The present elevated railroads are very much overcrowded, owing to the fact that they have a very large traffic, and that the companies owning them do not supply a sufficient number of trains during the busy hours of the day. They find it more profitable to crowd people like cattle into their cars than to run cars enough to give decent accommodation. They have also managed with great skill to produce the general impression that it is impossible to run more cars, and, consequently, the great imbecile public submits with much meekness, while the nickels flow into the coffers of the company in a never-ceasing stream, which increases daily in volume. It may be true that on the Third Avenue line the limit to the number of trains which can be run has been reached, but there is no reason apparent why they cannot run as many trains on the other lines as they do on the Third Avenue. The Sixth Avenue road is terribly overcrowded in the morning and the evening, and more trains are urgently needed. The company, however, regards the discomfort of the people with great equanimity, and never seems to have cars or engines enough. They find that it is profitable to make the public stand up, and stand the public must. At present it vents its dissatisfaction by clamoring for more facilities for rapid transit up and down Manhattan Island, which is very curiously hedged in by obstacles which make ingress and egress difficult. On the one side is the East and on the other the North River, both wide streams, with strong tidal currents and liable to obstruction by ice in winter, and with an enormous commerce which cannot be obstructed by bridges, and in the case of the East River with a soil underneath exceedingly difficult to tunnel. On the south there is Staten Island, which is unhealthy, and on the west the Jersey flats, equally so, and in other ways malodorous. Business is concentrated in New York, and the problem is to afford means for people to go to and from their business daily. A project for a tunnel under the East River is being actively pushed, and seems only to require the consent of the Board of Aldermen. Schemes for bridges over both rivers are heard of, and the tunnel under the North River bubbles up in the mud and silt periodically with more or less vigor.

In New York City the relative merits of underground, overhead, and open-cut roads have been discussed for more than half a century without thus far reaching any definite conclusion. Briefly, the arguments for and against them may be summed up as follows :

Underground railroads are damp, dark, and disagreeable. No other motor is now available for a fast and heavy traffic excepting steam locomotives, which means bad ventilation and general discomfort. It may be stated, generally, that people will not travel underground if they can do so above. It seems as though that long period of underground residence which is in store for all of us creates a natural aversion to being there while it is possible to be on the earth's surface or above it. An open-cut railroad is not practicable in our streets or avenues, excepting, perhaps, in some of the newer ones up-town, because they are not wide enough. To acquire property for building such a line would be enormously expensive, and an open road would also be liable to obstruction from snow. It would be necessary, too, to carry all cross streets over such a road on bridges. In traveling on it there would therefore be a constant and quick alternation from daylight to darkness, which would be excessively disagreeable. To elevated roads in the streets there is now a strong public sentiment opposed, owing to the injury to property and to the difficulty of getting redress from a powerful corporation. There remains, then, only an elevated or overhead railroad built through private property. This means, of course, the acquisition of the property for the right of way, which, of course, would be enormously costly. But the experience with the elevated railroads has shown that there is little difficulty in constructing or operating a line of road at a height varying from 20 to 40 ft. above the street. If, then, a road should be constructed through private property, at a height of 30 or 40 ft. above it, the space below it would still be available for various uses, and could be made to yield a revenue to its owners. It would be possible, too, to erect buildings two or perhaps more stories high on the property, whose walls would serve the twofold purpose of supporting the railroad and enclosing the space below. If these were made fire-proof they would answer for storage warehouses, workshops, and many other purposes for which the noise of the trains would be no objection. A company of good financial standing could borrow money at a low rate of interest, and the rental of the buildings would, at least in part, pay the cost of the property. The present building laws permit of the covering 65 per cent. of a lot with a building. If these structures were erected with strong front and rear and intermediate walls, they could carry the railroad, and the side walls would help to give stability to the whole structure. The streets would be crossed by continuous iron-plate girders supported on iron posts at the curbs and on the front walls of the building. Other girders, either continuous or not, would extend from the front to the rear wall, and still others would span the space between the rear walls on adjoining lots. The front, rear, and intermediate walls could be arched so as not to interfere with the uses of the building, and at the same time give adequate strength for supporting the railroad. When stations are required they could be located on the property below the road with ample waiting-rooms and conveniences for the public. The girders could be made of such a height as to come up to the window-sills of the cars. The lower part of the train would thus be hidden from view from below, but passengers could see into the street from the windows. Such a road would not be expensive to construct, would not occupy the streets excepting to cross them, and would injure adjoining property less than any other form of elevated road. It would give abundant light and air to those who travel on it, and would give altogether a much more agreeable way of traveling than either an underground or an open-cut road would.

FRENCH VIEWS OF THE PANAMA CANAL.

IN France, as is natural, a more hopeful view is taken of the situation of the Panama Canal than on this side of the water. The *Revue Scientifique* gives the following statement, which it claims to derive from official resources, of the present situation of the work done on the Canal.

The sea-level canal, as originally projected, has a total length from Colon to Panama of 74 kilometers, with a width of 22 meters at the bottom and 44 meters at water

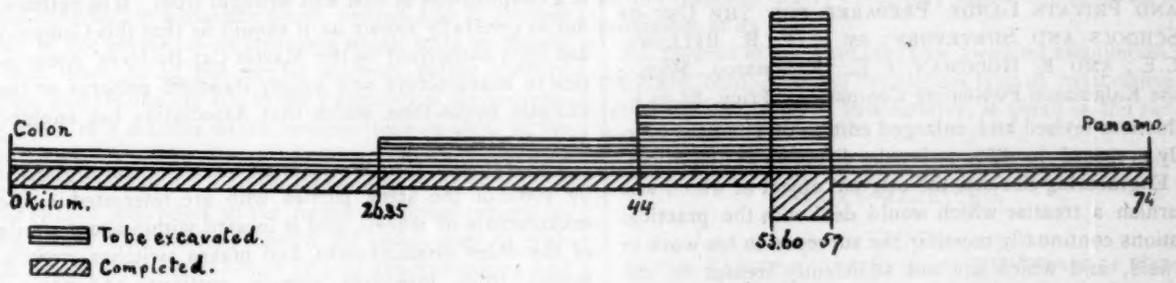
level. It was necessary to cut through hills of considerable size, which at certain points required the removal of a great mass of earth. It was in order to diminish in very large proportion this work that the Company has resolved upon the construction of a provisional canal, with locks having a lift of 38 meters, in this way raising the level of the canal by that amount for a long distance, and reducing the necessary amount of excavation by about 65,000,000 cubic meters. This canal with locks can be quickly made and put into use, and can then be producing revenue while the engineers are employed in the final completion of the sea-level canal.

The actual situation of the work at the present time is as follows: In the first division, extending from Colon to kilometer 26.35, there were in all 25,000,000 cubic meters of excavation, of which 19,000,000 have been completed.

In the second division, from kilometer 26.35 to kilometer 44, out of 24,000,000 cubic meters of excavation, 5,500,000 are completed.

In the third division, from kilometer 44 to kilometer 53.60, the difficulties are greater on account of the rocky nature of the country, and only 8,000,000 cubic meters out of 46,000,000 required are completed.

The fourth division, from kilometer 53.60 to kilometer 57, includes the great Culebra cut, in which are presented the most formidable obstacles to the work. This cut is through a schistous rock in horizontal strata, which slide one upon another in enormous masses. In spite of the many difficulties, it is believed that this problem will be solved, and it will only be necessary to employ men and machines enough to complete it. On this division 4,000,000 cubic meters have been taken out from the total of 27,000,000 required.



Finally, in the fifth division, from kilometer 57 to Panama, in which 14,000,000 cubic meters of excavation were required, the work is a little over one-half done.

The accompanying diagram shows in graphic form the state of the work, the lower portion, cross-sectioned, indicating the completed work on each section, while the upper portion, with heavy black lines, shows the amount still to be done.

The work on the iron locks, the contract for which has been let to M. Eiffel, is well advanced. The excavation for the locks has made considerable progress, while nearly 7,000 tons of iron for the locks and gates have been already completed, and the work is progressing actively in the shops of the Compagnie de la Loire at Nantes.

This is undoubtedly the best statement that can be made for the Canal, and it will be seen that the *Revue* takes no account of the collateral works necessary for the regulation of the Chagres River, which competent engineers believe to be the most difficult problem connected with the Canal. Even on its own statement, the amount of excavation required is still very formidable, while the most difficult portions of the work are hardly touched as yet.

The *Economiste Français*, which has stood almost alone among the French papers in criticising sharply the financial methods of the Company, thinks that the only solution of the problem possible now is the organization of a new company with a capital of not less than $50,000,000 and the surrender of the rights of the present bondholders, at least for a time. The subscriptions to the stock of the new company would enable it to continue the work with some prospect of completing it as a lock canal within three or four years. The problems—both engineering and financial—presented are, however, difficult enough to make even the warmest friends of the canal doubtful of their speedy solution.

NEW PUBLICATIONS.

NOTES ON MILITARY SCIENCE AND THE ART OF WAR: BY JOSEPH M. CALIFF, FIRST LIEUTENANT THIRD U. S. ARTILLERY, PROFESSOR OF MILITARY SCIENCE AND TACTICS, STATE UNIVERSITY OF IOWA. Cleveland, O.; The Borrows Brothers Company (price, $1).

This book gives in as brief and concise a form as possible the principles of the Military Art; it shows how the methods of handling men have changed from the time when they were assembled in heavy immobile masses, through the various changes of tactics down to the thin skirmish line of to-day; it also gives the organization of armies and their management; in short, in a concise but clear manner it shows how the game of war is conducted.

In addition to this, it gives the latest data regarding modern arms and military material—guns, projectiles, explosives, and torpedoes.

It is not a book for the professional soldier, as it gives only the framework and salient points of the subjects treated, such information as it is desirable to give to college students under military instruction, and which as educated men they should possess, or such as would be appreciated by any one interested in military affairs, but without the advantages of a military library or the time to give to a more serious study of the subject.

The total absence of any text-book on this subject renders it of especial value to all schools and colleges having a course in Military Instruction.

GEOLOGICAL SURVEY OF NEW JERSEY: FINAL REPORT OF THE STATE GEOLOGIST. VOLUME I.: TOPOGRAPHY, MAGNETISM, CLIMATE. Trenton, N. J.; State Printers.

The Geological Survey of New Jersey has always held high rank among similar works in this country for the excellence of its methods and the thoroughness with which its work has been done. It is now approaching completion, and Professor George H. Cook, the State Geologist, submits in the present volume the first part of his final report, which covers the topics given above.

Partial surveys were made in 1836–40 and in 1854–56, but the present survey was not begun until 1864. Its scope was gradually enlarged, until it reached the complete form which is indicated by the final report. It has been fortunate in two ways, in which some State surveys have

suffered—it has been continuously under the direction of the same competent head, and it has had steady support from the Legislature, so that the work could be carried on continuously and without breaks or delays. Under these circumstances it has been possible to keep the working force together, and there have been very few changes among the subordinates.

In the present volume the chapter on the Geodetic Survey is by Professor Edward A. Bowser; that on the Physical Description of the State, by Mr. C. Clarkson Vermeule, and that on the Climate, by Professor John C. Smock. All of these gentlemen have been long connected with the work.

Besides several smaller maps in the text the volume is accompanied by two large maps, one a geographical map of the State, the other a relief map, showing the elevations of the land. Both are admirable specimens of work and fully maintain the very high standard of the sectional maps heretofore issued by the Survey.

A MANUAL OF LAND SURVEYING, COMPRISING AN ELEMENTARY COURSE OF PRACTICE WITH INSTRUMENTS, AND A TREATISE UPON THE SURVEY OF PUBLIC AND PRIVATE LANDS, PREPARED FOR THE USE OF SCHOOLS AND SURVEYORS: BY C. F. R. BELLOWS, C.E., AND F. HODGMAN, C.E. Kalamazoo, Mich.; the Kalamazoo Publishing Company. (Price, $2.50.)

This is a revised and enlarged edition of a manual originally prepared in 1886, under the direction of the Michigan Engineering Society, the original object of which was to furnish a treatise which would deal with the practical questions continually meeting the surveyor in his work in the field, and which are not sufficiently treated by the books in existence, which deal entirely with the mathematical and instrumental part of surveying. With this view, in addition to the ordinary matter and tables given in such works, the present volume contains nearly 200 pages on Original Surveys, on Section Lines and Subdivisions as used in the surveys of Government lands, on Resurveys, Relocation of Landmarks and smilar questions, and on legal questions connected with the practical work of a land surveyor. This cannot fail to be of very great use both to those engaged in practical work and to students, and it certainly supplies a great deal of information which has not heretofore been readily accessible. It is the most practical work on the subject which has come under our notice, and a "preliminary survey" of its pages has failed to show any material errors. The book, we are informed, is already in use in a large number of colleges and technical schools.

It is published in a very neat form, and is bound as a pocket-book, its size and arrangement making it convenient for use as a field companion for the engineer as well as in the office.

CAR TRUCK AND TRACK EQUIPMENT. Issued by the Ramapo Wheel & Foundry Company, Ramapo, N. Y., and the Ramapo Iron Works, Hillburn, N. Y.

This is an illustrated catalogue which describes the different articles manufactured by the two companies whose names are on the title-page. These are, first, car wheels, in the manufacture of which the Ramapo Wheel & Foundry Company has long been celebrated. The wheels made by this Company are of two kinds—first, the cast-iron chilled wheels, and, second, steel-tired wheels. The quality of cast-iron wheels, like that of many other things—a pudding or a cocktail, for example—depends upon the quality of the material put into them. The irons used by the Ramapo Company are from the celebrated Richmond and Salisbury mines, which have been worked for a hundred and thirty years, and are especially suited for the manufacture of wheels.

The demand for steel-tired wheels has led Mr. Snow, the President of this Company, to design two different patterns of wheels of this kind. One of these has a cast-iron hub and cast-iron center which is held between two wrought-iron plates, all securely bolted together. One of the plates acts as a retaining ring to hold the tire. The other form of wheel has a solid cast-iron center. The tire is held on by a flange on the outside rolled on the tire, and which locks into a groove turned in the face of the wheel center. On the back the tire has a groove turned into it with a cut ring sprung in, which holds the tire in its place. A variety of cast-iron wheels for street, plantation, and other cars are illustrated.

This Company also makes a specialty of the manufacture of brake-shoes, among them the Congdon shoe, which is a combination of cast and wrought iron. It is, perhaps, not as generally known as it should be that this Company has been authorized by the Master Car-Builders' Association to manufacture and supply standard patterns of the Christie brake-shoe, which that Association has adopted as a standard.

The Ramapo Iron Works is an establishment organized by some of the same parties who are interested in the manufacture of wheels, and is located within about a mile of the older establishment, and makes switches, switch-stands, frogs, crossings, signals, castings, and general track equipment. Its products are very fully illustrated and described in the catalogue before us, the engraving of which is excellent, the typography good, and the paper luxurious, and which is a model of what such a catalogue should be.

SECOND ANNUAL REPORT OF THE INTERSTATE COMMERCE COMMISSION: THOMAS M. COOLEY, WILLIAM R. MORRISON, AUGUSTUS SCHOONMAKER, ALDACE F. WALKER, WALTER L. BRAGG, COMMISSIONERS; EDWARD A. MOSELEY, SECRETARY. Washington; Government Printing Office.

The Report of the Interstate Commerce Commission for 1888, which details the work of the second year of the Commission, is an able and interesting document, which should be widely read and carefully considered.

Dealing as it does, necessarily, with the financial rather than the technical side of railroad affairs, a careful or even general analysis of the report would be outside of the subjects usually considered in these pages, though the points considered by the Commissioners have so wide a range, and are presented in such a manner that they command the attention of all who are interested in any way in railroads, and this practically includes the whole community.

There are few who realize the task which was given to the Commission, in the attempt to unify and bring under a general system the vast interests of our interstate commerce, which has grown up so rapidly, without control and under various State regulations, or practically without regulation beyond the very elastic one of the patience of stock and security holders, or of the public.

The task of teaching those unaccustomed to more than this nominal control was alone one of the greatest difficulty, and on the other side the Commission had to face the indifference and ignorance of the public, who looked only to local and individual interests.

Their work has, therefore, been chiefly educational on both sides, and though this report shows that it has been done with both ability and tact, it also shows that there is a large work yet before the Commission, and impresses the importance of that work upon the reader.

The discussion of unreasonably low rates, and their effect, not only upon the corporations, but upon the public mind, is one of the most useful chapters in the report, showing, as it does, the fallacies affecting popular opinion on that point; and while it deals unsparingly with the errors of railroad management in that particular, does not fail to point, out that the public is equally to blame, and by its readiness to grasp at a momentary advantage is willing to inflict a real injury upon its own interests.

The further fallacy of the unity of all railroad interests is clearly and ably dealt with, and the points of the effect of the law upon cities, and the difficulties which surround the question of a uniform classification, are stated with equal care and in a manner which cannot fail to remove many of the erroneous impressions which exist in regard to both those, to all but careful students, rather obscure points, and thanks are due to the Commission for presenting them in a manner which renders them so clear to the general reader.

If it were within the limits of this notice, it might be possible to take exception to the forms of annual reports issued by the Commission, though the points open to criticism are those of detail rather than of general scope; and it would be impossible to deal with these without a longer and more careful inquiry than is possible here.

In conclusion, it can only be said that the Commission has shown by this report that it has amply proved the necessity of its existence and the wide field of usefulness which is open to it in the future.

ABOUT BOOKS AND PERIODICALS.

THE TECHNOLOGY QUARTERLY, issued by the students of the Massachusetts Institute of Technology, has in the December number an exhaustive article on Tests of the Strength of Cast Iron, by Professor Gaetano Lanza. There are also several other interesting articles by students and graduates of the Institute.

A new monthly, called ELECTRIC POWER, has made its appearance, its object being to set forth the advantages of the electric motor as a machine for the distribution of power. It certainly has a field to fill which is already large and is rapidly widening. It is published at 150 Broadway, New York, and is edited by Ralph W. Pope and George H. Stockbridge, both gentlemen well known as electrical engineers.

The CENTURY MAGAZINE for February gives a map of Siberia, showing the route followed by Mr. Kennan in his travels in that country. It appears that the greater part of his journey was on substantially the line which will be followed by the Siberian Pacific Railroad when it is built.

Mr. Edward Atkinson is the author of an interesting article in the same number on Slow Burning Construction, written with special reference to public buildings.

In HARPER'S MAGAZINE for January, Charles Dudley Warner tells of the coal, iron, and limestone deposits of Eastern Kentucky, and of the recent remarkable railroad development of that State, which has taken a new start after standing still for 20 years, in spite of its great natural resources. The article is interesting, though some of its statements seem rather enthusiastic.

An illustrated article on the Evolution of the Ferry-Boat, by S. Bayard Dod, appears in HARPER'S WEEKLY for January 5. This article contains an account of the progress made in ferry-boats since 1659, with special reference to the ferry from New York to Hoboken. During that year reference is made to an existing ferry which was kept by Cornelius Dircksen, who, having a farm near by, came at the sound of a horn, which was hung on a tree, and ferried passengers over for three stivers wampum. A description is also given of the horse-boat, which was the next form of ferry-boat, the power secured being equal to 40 oars or 10 times greater than the row-boats; the *Fairy Queen*, the old *Pioneer*, and other boats propelled by steam are illustrated, and the writer ends with a description of the handsome, modern ferry-boat *Bergen*, now being built for the Hoboken Ferry Company, which is the latest development of its class.

An account of the *Puritan*, now awaiting completion at the Navy Yard, Norfolk, the highest type of coast-defence vessel yet laid down in this country, is given in the same number.

BOOKS RECEIVED.

ANNUAL REPORT OF THE CHIEF OF THE BUREAU OF STEAM ENGINEERING, NAVY DEPARTMENT, FOR THE YEAR 1888: ENGINEER-IN-CHIEF GEORGE W. MELVILLE, CHIEF OF BUREAU. Washington; Government Printing Office.

SELECTED PAPERS OF THE RENSSELAER SOCIETY OF ENGINEERS: EDITED BY THE COMMITTEE ON PUBLICATION. Troy, N. Y.; published for the Society. This number includes a reprint of Mr. William H. Burr's paper on the Theory of the Masonry Arch, originally published in 1881, and now reproduced, with a few changes and additions, to meet the continued demand for it, the first edition having been exhausted.

THE TECHNIC: ANNUAL OF THE ENGINEERING SOCIETY OF THE UNIVERSITY OF MICHIGAN. Ann Arbor, Mich.; published by the Society. This volume contains selected papers read before the Society during the year, some account of its proceedings, items of interest relating to the University and other well-chosen matter. It is illustrated by portraits of Professor Greene and the late Professor Cheever.

TRANSACTIONS OF THE INSTITUTION OF CIVIL ENGINEERS OF IRELAND: FIFTY-SECOND YEAR, TO JUNE, 1887. Dublin, Ireland; published for the Institution.

THE ECONOMICAL PRODUCTION OF CHARCOAL FOR BLAST-FURNACE PURPOSES: BY OLIN H. LANDRETH, ENGINEERING DEPARTMENT, VANDERBILT UNIVERSITY. Nashville, Tenn.; reprinted from the *Proceedings* of the American Association for the Advancement of Science.

GEAR TABLES FOR LAYING OUT ACCURATE TOOTH PROFILES FOR THE USE OF PATTERNMAKERS, MACHINISTS, DRAFTSMEN, AND STUDENTS: BY J. F. KLEIN, PROFESSOR OF MECHANICAL ENGINEERING, LEHIGH UNIVERSITY. Bethlehem, Pa.; Edwin G. Klose, Manager.

MEMORIAL TO THE STATE LEGISLATURE OF MISSOURI: DRAFT OF AN ACT TO PROMOTE THE SAFETY OF BRIDGES. Issued by the Engineers' Club of Kansas City.

UNIVERSITY OF MICHIGAN; THE PRESIDENT'S REPORT TO THE BOARD OF REGENTS FOR THE YEAR ENDING SEPTEMBER 30, 1888. Ann Arbor, Mich.; published by the University.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY: TWENTY-FOURTH ANNUAL CATALOGUE, 1888-89. Boston, Mass.; published by the Institute.

CORNELL UNIVERSITY, COLLEGE OF AGRICULTURE: BULLETIN OF THE AGRICULTURAL EXPERIMENT STATION, No. III. Ithaca, N. Y.; published by the University.

IMPERIAL UNIVERSITY OF JAPAN (TEIKOKU DAIGAKU): CALENDAR FOR THE YEAR 1888-89 (XXI-XXII YEAR OF MEIJI). Tokyo, Japan; published by the University.

IMPROVEMENTS IN THE CONSTRUCTION OF STEAMSHIPS AND RUDDERS AND IN LOCATING RUDDER AND PROPELLERS: BY WALFRID THEODOR SYLVEN. Washington; published by the Author.

THE VIVARTTAS SYSTEM OF CREMATING GARBAGE AND REFUSE. Plainfield, N. J.; issued by the Seaboard Sanitary Garbage Cremating & Refuse Utilizing Company, Seymour G. Smith, Secretary.

THE LONG-SUFFERING SHAREHOLDER. RAILROAD DIRECTORIAL MISMANAGEMENT AND GOVERNMENTAL OPPRESSION: BY HENRY WOOD. Boston; published by W. B. Clarke & Company.

THE TAYLOR IRON WORKS DIARY FOR 1889. Issued by the Taylor Iron Works, High Bridge, N. J. This Company has sent out its usual yearly reminder to its friends in the form of a very neat and convenient pocket diary, containing, besides the usual diary and memorandum pages, a variety of notes on strength and weight of metals, tables, and other information often very convenient for reference.

CALENDAR MEMORANDUM TABLET. Issued by Pedrick & Ayer, Philadelphia. This is a very convenient memorandum tablet for the desk, containing on each page spaces for memoranda for six days, and an engraving of one of the special tools made by the firm.

FINAL ESTIMATES AND CLASSIFICATION OF WORK.

To the Editor of the Railroad and Engineering Journal:

IN reading the paper on the Principles of Railroad Location in the January number of your JOURNAL, that chapter which relates to Final Estimates attracted my attention, and I wish to offer a couple of suggestions on the subject of Classification, based on a considerable and varied experience as engineer and contractor on railroad and other works.

An objection to the classification in the clause denominating boulders and detached masses of rock up to four yards in quantity as "loose rock."

I should rather make one-fourth of a yard the limit. A boulder of four yards will weigh say 18,000 lbs. It is necessary, ordinarily, to drill and blast boulders of one yard weighing 4,500 lbs., as in earth cuts. Where such boulders are usually found, contractors do not have derricks or other appliances for handling such stones, and where there are derricks it is not customary to rig them for a load of over one yard, while the ordinary small dump-car will not carry over two yards. Where classification is used it should be based entirely on the cost of excavating the materials, and it certainly costs more per yard to handle detached boulders or masses of two, three, or four yards than the same number of yards of solid rock in a rock cut.

I was engaged on the construction of a railroad where the specification stipulated that rocks up to 20 cubic yards in size were to be "loose rock," but that all rock that could not be removed without blasting was "solid rock." Of course the latter clause wiped out the former, as no one could handle a 20-yard mass of rock economically without blasting.

In the opinion of a number of eminent engineers with whom I have talked on the question of classification, as well as my own, work should be let without classification.

Contractors are usually far better qualified to estimate the cost of grading than engineers, and after examining the work carefully by means of test pits or borings, where the heavier cuts occur, can bid intelligently, taking the whole as one class; of course the price per yard would vary upon different sections as the materials to be excavated varied.

In eliminating classification, the most disputed and serious question between contractors and railroad companies is removed, and many vexatious delays in settlements and lawsuits averted.

The Pennsylvania Railroad—the most progressive, best maintained, and systematized, as well as the strongest railroad company in this country—is now letting its work largely without classification, which practice goes far to prove the theory to be a correct one.

Tarrytown, N. Y. FRANK NEARING.

PETROLEUM FUEL.

To the Editor of the Railroad and Engineering Journal:

AMONG much that is interesting in the RAILROAD AND ENGINEERING JOURNAL for November, 1888, is an article on page 509 on Petroleum Fuel. The comparative points made relative to the evaporating power of petroleum and coal are entitled to the most careful consideration and due respect, and the public is more widely affected by the facts contained in the statement made, than the casual reader or observer may comprehend. In a word, it touches the cash account of all who provide fuel for heating space or substance for comfort, power manufacturing, and domestic purposes. All of these reach out a long and powerful arm as positive as a grip of the devil-fish, and materially affect the bank account of all concerned, whether consumers or producers. But concomitant with the use of petroleum in a liquid state is the possibility, or reasonable fear of a destruction of life and property. It may be made as faithful a servant in trained hands as lightning, steam, or nitroglycerine, all of which are safe under the right conditions, but the public are not all mechanics, engineers, chemists and philosophers. Nevertheless, all are in some way interested in results from heat in this world—to say nothing of the next. Life is dear to all, and the majority prefer to stay in this world as long as they can, whatever their future crop may be from seed sown here. It is not good judgment for an engineer to calculate the tensile strength of iron, of any make and size, to make a chain to lift a load and have it just strong enough to lift it over the heads of living persons; he should steer clear of all possibility of accident when it can be done, and build a chain so that there can be no possibility of its breaking with a good load. So with liquid petroleum as fuel. Scientifically its combustion with water or hydrogen gas and air, etc., is all well enough, but is it not better to have it so that it is as safe as a loaf of bread—still preserving all the benefits of heat—than to have a liquid lightning to strike and consume? I do not mean by this the use of any system of absorption giving rise to danger and filth. Petroleum, or any grease or oil can be so heated as to be as safe and as neat as wood or coal, and still be equally effectual as in a more dangerous way.

I do not presume to argue points but to state facts. In the latter way—refined—it can be burned in any place where wood or coal is burned. Petroleum or any grease can be as effectually, safely, and neatly used as coal or wood, and can be kept in a box or coal-hod like them. I am not manufacturing this article for sale, but it is perfectly practicable, and were I not so much engaged I would, I think, bring this matter out for the public. I never have advocated it, because "a little learning is dangerous"—and less is more dangerous. This maxim proves true all along the line of artisans, manufacturers, etc., of whom it can be truthfully said and corroborated that far too many think of their positions, or job that of facts, progress, improvement, quality, and cost of production.

GEORGE VINING, M.D., Chemist.

THE DEVELOPMENT OF THE MILITARY RIFLE.

By Lieutenant Joseph M. Califf, Third U. S. Artillery.

(*Continued from page* 8.)

MAGAZINE OR REPEATING RIFLES.

The above was the condition of the military small-arm armament at the beginning of 1884. Magazine arms of the Spencer, Henry, Burnside and Sharp patterns had been used to a considerable extent during our Civil War by scattered organizations, but the system, both here and abroad, was confined almost wholly to arms for mounted troops--no nation having adopted it for infantry.

During the three years following the date mentioned the Germans converted their Mauser (1884) into a magazine gun, with a tubular magazine under the barrel for eight cartridges. Austria adopted the Mannlicher repeater (1885), an entirely new arm ; the magazine, in the shape of a tin case or box holding five cartridges, was attached under the breech and fed directly into the receiver, and was removed and thrown away when empty. The English military authorities decided to convert their Martini-Henry into a magazine gun of reduced caliber, but before the change had been completed the proposed adoption of a still smaller caliber by Continental powers stopped further progress.

The latest revolution in small-arms is as complete, and the changes suggested quite as radical, as any that have preceded it. Professor Hebler, a German scientist, seems to have been one of the first to advocate a decided reduction in the caliber of military rifles (1886). The announcement that with a bullet of only about 8 mm. diameter, greater range, accuracy and penetration, with less recoil, could be obtained than with those of any of the existing systems, was received with incredulity, if not ridicule, by the military experts. Investigation and experiment have shown, however, that these claims are fully substantiated, and almost before the re-armament of the great Continental armies with the large-bore magazine rifle has been completed, the work and vast outlay of another re-armament must be undertaken. The advantages of a lighter arm with a lighter bullet, provided they will do the work required of them, are obvious, and, with quick-firing arms, in no way more than in the largely increased number of cartridges that can be carried by the individual soldier.

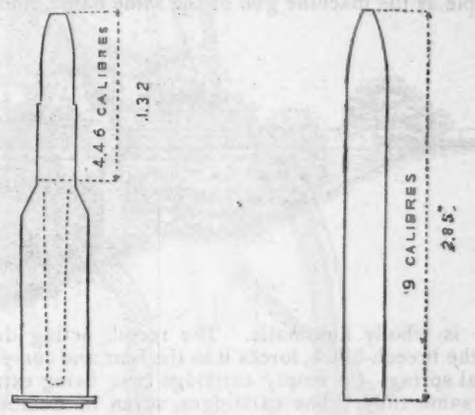
In the Hebler system the rifle has a caliber of 7.53 millimeters (0.296 in.). The cartridge case, of thin steel, contains a 225-grain bullet, 4.46 calibers in length, and a charge of 83 grains of compressed powder, perforated throughout its length to secure instantaneous ignition of the whole interior surface of the charge. The bullet is covered with a thin nickel-plated steel shell (fig. 16).

The French, in their Lebel rifle—which is said to be a modified Gras—have an arm for which greater results are claimed than those obtained from the Hebler. The details concerning this arm and its ammunition are guarded so closely that but little reliable information has been obtained concerning it. It has a caliber of 8 mm. (0.315 in.) ; uses a smokeless powder, from which an initial velocity of 630 meters and a range of 4,200 meters is claimed, against an initial velocity of 600 meters claimed for the Hebler. The bullet is said to have the extraordinary length of *nine* calibers. If these reports are correct, fig. 17 would represent the actual dimensions of this bullet. The powder is supposed to be a gun-cotton or nitrated powder of some kind. Like the Hebler bullet, that of the Lebel is steel cased. The object of this metal covering for the bullet is that in all these small-caliber arms the relative length of the projectile to its diameter is so great that an excessive twist of groove is necessary to obtain sufficient rotary motion to prevent its "tumbling." Lead of itself was found too soft—it stripping badly—and after many experiments with various alloys of lead, and with all-steel projectiles, the best results were obtained by casing a lead bullet with copper, soft steel, nickel or German silver. The magazine of the Lebel rifle is tubular and under the barrel, and contains eight cartridges. More than 300,000 of these arms have already been issued to the French army, and it is expected that before the close of the present year the entire active force will be re-armed with the small caliber magazine rifle.

The new small-caliber Austrian magazine rifle, the manufacture of which that Government is pushing with all possible despatch, is of the Mannlicher model, of 8 mm. caliber, using a 240-grain steel-cased bullet, four calibers in length, and a charge of 62 grains of compressed brown powder. An initial velocity of 520 meters, with a range of 3,800 meters, is claimed for this arm. The issue of the new arm has already begun.

In Germany it is said that a small-caliber magazine rifle has been decided upon, but no details of the proposed arm have as yet been published ; but it is presumed that it will be a modification of the Mauser, their present arm.

The English military authorities, after many experiments with several patterns of magazine rifles, seem to have settled finally upon the Lee—or, as they call it, the



16 17

Improved Lee. This is an American arm, and one of the three issued to our own troops for trial four years ago. The caliber has been reduced to 0.303 in., the magazine is detachable, contains eight cartridges, and is attached just in front of the trigger-guard. The cartridge has not yet been decided upon. The one proposed uses 70 grains of compressed black powder and a copper-covered bullet of 217 grains.

In the United States the question of a magazine rifle of any kind is still in abeyance. In 1885 a considerable number of arms of the Lee, the Chaffee-Reece and of the Hotchkiss were issued to the army for trial. After a trial of something over a year, reports were submitted to the Ordnance Department by the officers having them in charge. In a majority of these reports preference was given to the Lee, but its adoption was not generally recommended. Many of the objections to this arm seem to have been of a trivial nature—that it was not adapted to the manual ; could not use reloaded ammunition satisfactorily ; that the sights were objectionable ; and, the most serious one of all, that it was liable to discharge during the process of loading. At any rate, in this case our English cousins seem to have been able to turn the tables upon us and improve upon a Yankee invention. In the mean time, we are, Micawber-like, "waiting for something to turn up" in the line of a magazine rifle that shall please our Ordnance Department, conscious that we possess an arm which, fifteen years ago, might have been near the head of the list, but is certainly now rapidly approaching the foot.

In the recoil system we have the latest phase in the development of the military rifle. In it the force of recoil is made to do a part or the whole of the work of reloading the piece. Three different methods of utilizing the force of recoil have been developed. In the Freddi rifle (Italian), when the piece is fired the recoil forces the barrel (which is free to move in the direction of its axis) and breech-block to the rear and compresses a spiral spring. When the recoil is expended this spring throws the barrel

forward, but the breech-block is caught and held to the rear, leaving the receiver open. A fresh cartridge is inserted by hand. By pressing a button the breech-block is released and flies forward, closing the breech. The piece is cocked when the bolt first moves to the rear under the impulse of the recoil. In this system the force of recoil is made to perform the operations of opening and closing the breech mechanism, in addition to ejecting the empty case —operations which, in the ordinary magazine rifle, have to be performed by hand. A leather case, holding twelve cartridges, may be attached to the side of the piece, and great rapidity of fire secured.

In the Paulson system the breech mechanism is opened and the shell extracted by means of a rod attached to the breech-block; the powder gases being allowed to enter an aperature in the barrel and act upon the head of the rod as upon a piston. The cartridge is inserted by hand, and the release of a spiral spring, which has been compressed by the recoil, closes the breech. This arm may be used as a repeater by attaching a magazine to the side of the piece.

The Maxim recoil rifle is constructed upon the same principle as the machine gun of the same name, and in its action is wholly automatic. The recoil, acting directly upon the breech-block, forces it to the rear and compresses a spiral spring—the empty cartridge case being extracted at the same time. The cartridges, seven in number, are inserted by hand in as many receptacles in a revolving drum under the receiver. When the breech-block moves to the rear under the impulse of recoil, a system of levers acting on the drum revolves it under the receiver to supply a new cartridge. The compressed spring then forces the breech-block forward, pushes the cartridge into the chamber, and closes the breech. If the trigger is held back the firing-pin will be released and the firing continued until the cartridges are exhausted. The breech-block can be operated by hand and the piece used as a single loader.

The most important advantage of the introduction of the small-caliber rifle, from a purely practical military point of view, is, as has been said, the largely increased number of cartridges the individual soldier can carry upon his person to the field of battle, which has become a question of vital importance with the introduction of quick-firing arms. As showing how greatly this diminution of caliber has effected this supply, it may be said that with the Lebel rifle 116 cartridges of the old caliber are equivalent in weight to 220 of the new; that the cartridge proposed for the Lee has but little more than half the weight of that of the Martini-Henry; that with the Austrian 8 mm. rifle, 100 of the old caliber equals 146 of this arm; and that a soldier armed with the Hebler rifle could carry 107 rounds of ammunition as an equivalent of 80 rounds of our own Springfield.

A GERMAN FOOT-BRIDGE.

THE accompanying engraving, from *Le Genie Civil*, shows a foot-bridge of very neat design, which crosses the River Oker in the park which has been made on the site of the ancient fortifications which formerly surrounded the city of Brunswick in Germany. This bridge was built after the plans of M. E. Haeseler, Professor in the Polytechnic School at Brunswick.

Near the bridge the river makes a curve of about 40 meters' radius, and the banks are high. To join the park road on the left bank with the city street, which runs near the right bank of the river, a slight grade was necessary, and the bridge has a fall of 1.50 meters in its entire length. At the point where it is built the soil is chiefly sand, and it was necessary to rest the piers on piles. Upon these piles there is built a foundation of masonry of cut stone, upon which the piers rest. The masonry of the piers and abutments is of limestone.

At the point of crossing, the river is about 22 meters in width, but the central span is 24 meters in length, the general form and design being shown in the engraving. The side spans nearest the banks, which are plain girders without the supporting arch of the central span, are 13 meters in length. These side spans were used instead of filling in, in order not to interfere with the view of the park. The bridge is 4 meters in width, the whole being given up to the foot-walk with a railing on each side.

The side-spans have four simple lattice girders 13.40 meters in length, and spaced 1.20 meters apart. These girders carry the cross-beams supporting the foot-walk. The central span consists of two arched girders 3 58 meters apart, the ends resting in sockets made in the piers, and carrying the girders supporting the roadway, as shown in the cut.

In order to resist wind pressure the girders of the side spans are tied together by cross-bracing and by diagonal rods. In the central span the arched girders are also joined by cross-bracing, while the lattice girders above the arch are braced in a similar way. The ends of the arched girders are joined to the sockets on the piers by pins 60 mm. in diameter.

The planking of the foot-walk is 85 mm. thick, and is of oak and of beech. The beech planking was treated with chloride of zinc before being laid down, and has worn exceedingly well during the time it has been in service. The planking is fastened to the transverse girders by bolts. The guard-rail is 10.8 meters in height above the planking.

The total cost of this bridge was $9,200, the masonry work and substructure costing $5,200 and the iron-work $4,000. The design is certainly very neat, and agrees very well, apparently, with the nature of the surroundings.

NOTES ON STEAM HAMMERS.

BY C. CHOMIENNE, ENGINEER.

(Translated from the French, under special arrangement with the Author, by Frederick Hobart.)

(*Continued from page* 30.)

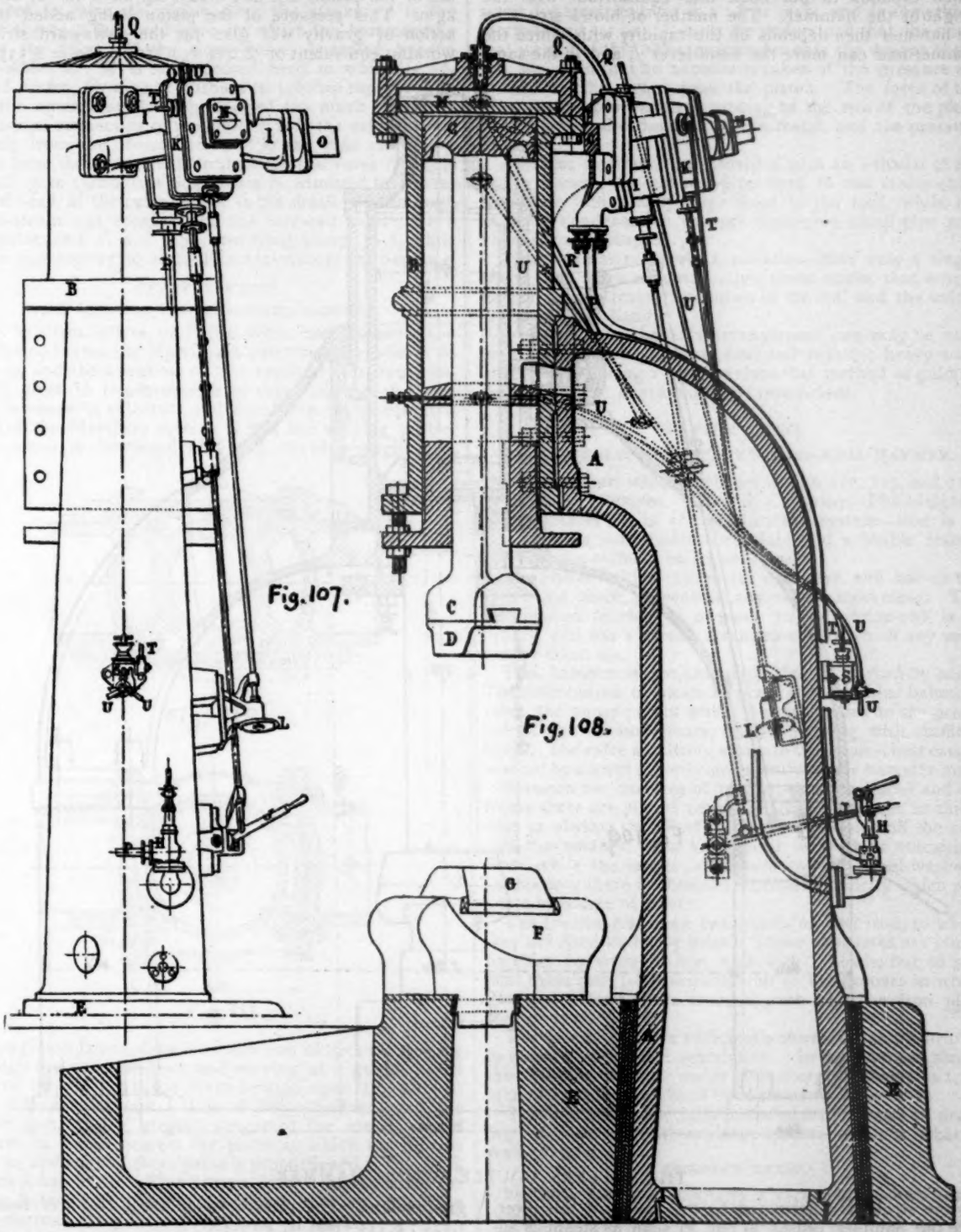
CHAPTER XXXI.

THE FARCOT DOUBLE-ACTING HAMMER.

THE principle upon which this hammer is constructed differs from that of other similar tools in this respect, that the lifting of the hammer is produced by a steam-chest or reservoir placed for that purpose below the cylinder. This type is represented in figs. 107 and 108, which show a hammer of 1,250 kilos., which is so planned as to leave the anvil entirely free. The cylinder incloses an iron piston, the rod of which has a rectangular section, thus preventing any rotary movement. At the lower end of this rod is carried a steel block, which forms the ham-

mer proper and which strikes on an anvil fixed to the bed-plate.

The cylinder *B* has its upper head of cast iron made with a recess greater in diameter than that of the piston; within this recess is placed a light plate which works freely like a piston. Steam is admitted to this head above the plate, as shown at *M*, and thus serves as an elastic cushion



THE FARCOT DOUBLE-ACTING HAMMER.

to prevent any shock to the upper part of the cylinder, in case the stroke of the piston is prolonged too much.

In this system the frame is made hollow, and it forms a reservoir in which steam is kept at a constant pressure—about two atmospheres—by means of a balanced valve, which admits fresh steam whenever the pressure diminishes in this reservoir. The capacity of the latter can be increased by the addition of water. The steam which it contains produces a counter-pressure and causes the piston to ascend as soon as the exhaust-port above it is opened and the upper end of the cylinder placed in communication with the air. This steam is not exhausted, but acts as a simple spring to lift the hammer after the down stroke. The result of this arrangement is that the waste space in the steam-chest and ports, which in other hammers occasions loss of steam, is dispensed with.

The force of the blow is regulated by the pressure and by the duration of the admission of steam above the piston; this steam forces down the hammer, at the same time

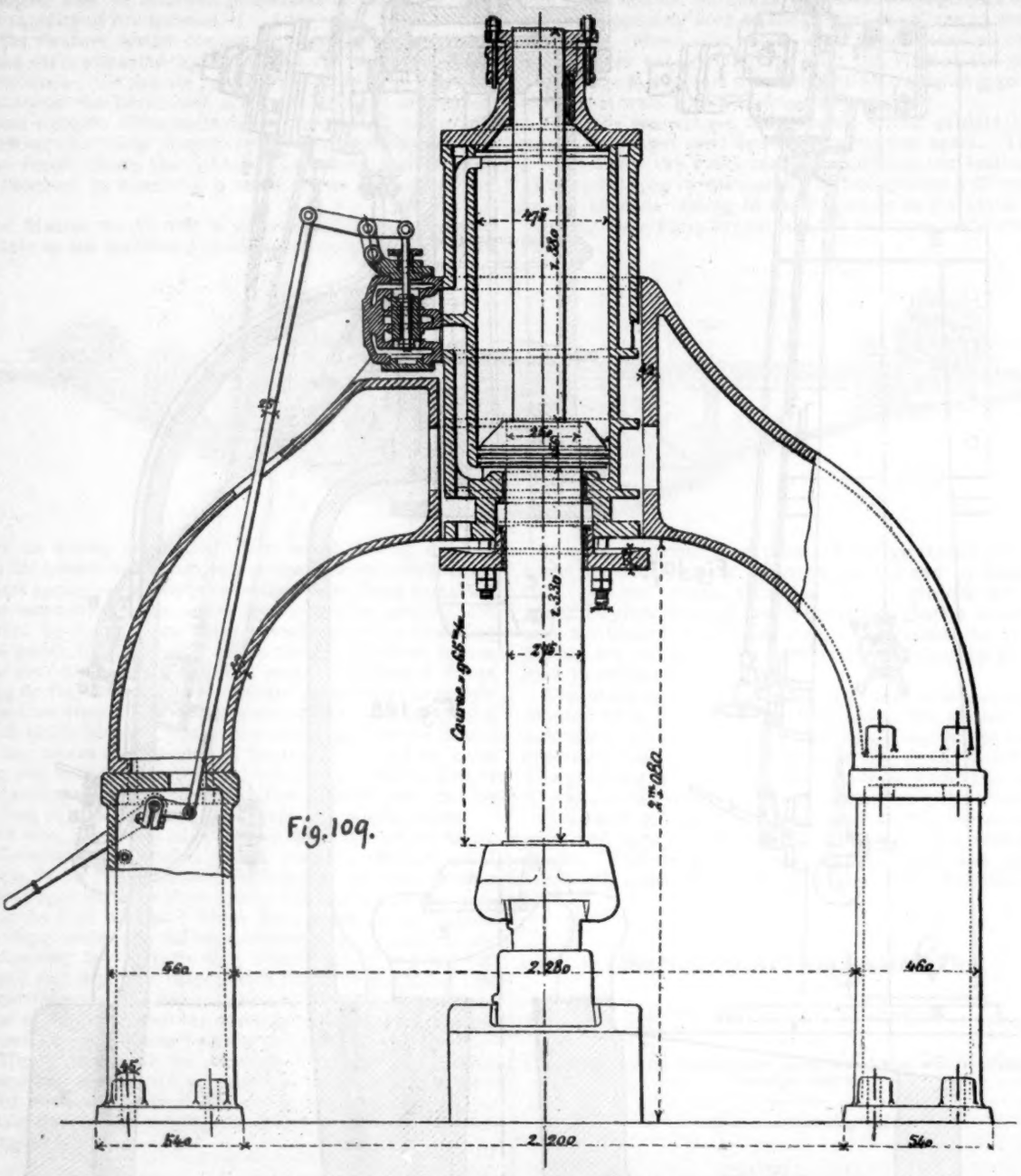
compressing the steam in the reservoir *A*, which ought to be kept at a pressure at least three atmospheres below that of the boiler. As soon as the valve is left free it is raised by springs placed on the rod *L*, and, the steam above the piston escaping, the hammer is lifted by the pressure of the steam in the reservoir below the piston, which expands to put itself into equilibrium with the weight of the hammer. The number of blows struck by the hammer then depends on the rapidity with which the hammerman can move the hand-lever *J*, and in the same way the stroke is determined by the action of this lever, since the hammer ceases to rise as soon as steam is admitted above the piston *C*.

The force of the blow can be decreased by stopping the admission of steam before the end of the stroke of the piston, so that the expansive force of the steam can be utilized, and the hammer can thus be worked very economically.

The following examples will show the value of this system of hammer, in comparison with a single-acting hammer. If we suppose a single-acting hammer of 1,250 kilos. and 0.900 meter stroke, the work produced during this fall will be :

1,250 kg. × 0.900 m. = 1,125 kilogrammeters.

With a Farcot hammer of the same weight, having a cylinder 0.512 meter diameter working with a steam pressure of 6 kilos. and a counter-pressure of 2 kilos., the pressure of the piston will be : 0.2058 sq. m. × (6—2) = 8,232 kgm. This pressure of the piston being added to the action of gravity will give for the downward stroke a working equivalent of (8,232 + 1,250) 0.900 = 8,533 kilogrammeters. The ratio between these two will then be 1,125 : 8,533—that is, 1 : 7.58.



THE SELLERS DOUBLE-ACTING HAMMER.

If now we assume that steam acts at full pressure only during one-third of the stroke, and that it expands during the other two-thirds, the mean pressure of steam would become 4.18, and the total pressure exercised on the piston would be :

0.2058 sq. m. × (4.18—2) = 4,486 kilogrammeters.

The work done during this descending stroke will be :

(4,486 kg. + 1,250 kg.) × 0.900 = 4,662 kilogrammeters.

The ratio between these two will then be only 1,125 : 4,662—that is, 1 : 4.14.

In the accompanying illustrations *A* is the frame ; *B* the steam cylinder ; *C* the piston ; *D* the shoe ; *E* the foundation-block ; *F* the anvil ; *G* the die ; *H* the balanced valve, the object of which is to keep at a constant pressure the steam contained in the hollow frame, this pressure being sufficient to raise the piston after the stroke ; *I* is the steam-chest ; *J* the hand-lever by which the hammerman works the valve ; *K* the steam-valve, operated by the hand-wheel *L* ; *M* is the recessed head to which is admitted steam, forming a cushion to take up the shock in case the upward stroke is prolonged too much ; *N* is the steam-pipe connecting to the boiler ; *O* is the exhaust-pipe leading from the steam-chest ; *P* is the pipe conveying steam from the steam-chest to the balanced valve *H* ; *Q* is a small pipe through which steam is admitted to the recessed head of the cylinder ; *R* is the small pipe through which steam can escape from the recessed head ; *S* is a lubricator, and *T* is a pipe conveying steam to *S*, while *U* is a pipe conveying oil to different parts of the hammer.

CHAPTER XXXII.

THE SELLERS DOUBLE-ACTING HAMMER.

Mr. William Sellers, of Philadelphia, has introduced in the United States the Morrison steam hammer, shown in fig. 109, and the attention of this engineer has been constantly given to improvements of this tool in such a way as to increase its efficiency and durability. The essential point of the Morrison system is that the striking part of the hammer is composed of a long rod of wrought iron,

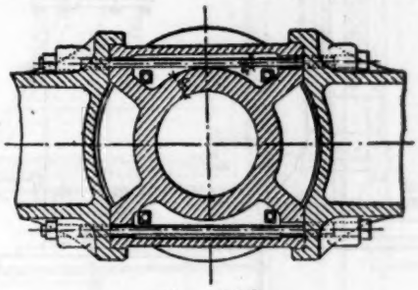


Fig. 110.

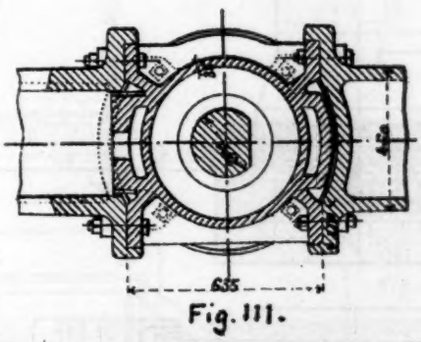


Fig. 111.

with a piston fastened on the upper end of the rod, passing through the cylinder-head and serving as a guide. This part of the rod has a flat place formed upon it to prevent any rotary movement. It is of less diameter than the lower part, as the greater weight of the metal should always be found nearest the point at which the blow is struck, and each of these parts is proportioned to the work which it has to do. This system leaves consequently the space below the cylinder completely free and gives the hammerman every facility for doing his work.

The frames are made with each leg in two pieces, and carry the cylinder on their upper part ; between the cylinder and the frame an elastic cushion is placed. Between the two parts of each leg of the frame also there is placed a thin plate of wood, which permits a certain movement under the strains resulting from the shocks of the hammer, the object being to decrease the chances of breakage.

For hammers having very hard work the rod is made of steel and the piston is reinforced.

The lower bolts which fix the cylinder to the frames are arranged in such a way as to be exposed to a current of air in order to decrease the expansion resulting from the radiation of heat from the piece to be forged.

There is nothing particular to note in the foundations. The ratio between the weight of the hammer and that of the anvil is 1 : 5 when the hammer is intended to work iron ; for steel its ratio is 1 : 8 at least, and is sometimes increased to 1 : 10. It must be understood that the nominal weight of this hammer includes only the weight of the rod, etc., and that no account is taken of the pressure exercised by the steam upon the piston. The force of the blow necessarily varies according to the size of the piece to be forged, the ductility of the metal, and the pressure of steam.

All these hammers are provided with an exhaust of the Collin system, the exhaust-pipe fixed to the steam-chest extending into a large pipe fixed to the roof, while the water of condensation escapes through a small pipe provided for that purpose.

These hammers below 1,000 kilos. have only a single frame, and work automatically ; those above that weight have a double frame, as shown in the cut, and the valves are worked by hand.

It will be seen that this arrangement can only be used for comparatively short strokes, and that for heavy work or die-work having a large surface this method of guiding the piston from above would be insufficient.

CHAPTER XXXIII.

BEMENT, MILES & COMPANY'S 2,700-KILO. HAMMER.

This hammer, which is shown in figs. 112, 113, and 114, is made by Bement, Miles & Company, Philadelphia, United States ; it is of the Morrison system—that is to say, with an independent bed-plate and a double frame, carrying the cylinder on its upper part.

The piston-rod is 0.250 meter diameter, and has on the side a flat place, preventing any rotary movement. The stuffing-box serving as a guide to the piston-rod is of bronze, and has a special arrangement by which any wear can be taken up.

This hammer is not automatic, but is worked by hand. The distribution of steam is made by a circular balanced valve, the upper part of which is exposed only to the pressure of the exhaust steam, thus dispensing with stuffing-boxes. The valve admitting steam to the steam-chest can be worked by a lever placed conveniently for the hammer-man.

Between the surfaces of contact of the cylinder and the frame there are placed copper plates of 1.5 mm. in thickness to obviate the effects of shocks. Under all the nuts and the smaller bolts are placed washers of vulcanized fiber, while the larger bolts have concave steel washers. In this way there is obtained a certain elasticity which prevents breakage of bolts.

The frames rest upon two blocks of cast iron, to which they are fixed by heavy bolts. These two plates are joined together by wrought-iron rods with T-heads, but to prevent these rods from working out of the grooves in which they are placed, there is upon each head an iron plate riveted to the block.

The foundations are sufficiently shown in the illustration to require no detailed description. In the hammer shown the cylinder is 0.610 meter diameter, the stroke is 1,220 meters, and the weight of the hammer is 2,700 kilos.

This hammer is specially intended for forging and drawing out bars. For die-work the system of guides is hardly well adapted.

CHAPTER XXXIV.

BEMENT, MILES & COMPANY'S 15,500-KILO. HAMMER.

This hammer, shown in figs. 115, 116, and 117, was built in 1880 by Bement, Miles & Company in Philadelphia, for the Steel Works of Park Brothers & Company in Pittsburgh.

The frame is composed of four hollow legs of rectangular form, built up of plates and angle-bars. Each group of two legs carries a girder which unites them by means of bolts, and these girders in their turn carry the upright frames to which are fixed the guides. These upright frames are joined at the top by the steam cylinder ; the girders

are joined together by heavy wrought-iron plates, somewhat like the Creusot hammer.

The diameter of the steam cylinder is 1.010 meters, and the maximum stroke of the hammer 2.750 meters. The piston-rod is of steel, and its diameter is 0.280 meter. The rod is attached to the piston by a nut.

This hammer, being intended to forge very heavy pieces, is not automatic, but is worked by hand by the hammerman, who is placed on the level of the ground and between the two legs, and has near him a lever moving the valve admitting steam to the chest, as well as the lever commanding the distributing valve. This valve is flat and is perfectly balanced; it works vertically between two rigid surfaces, and is so easily moved that the safety levers, placed above the sides and worked by a lug placed on the hammer in order to prevent accidents, should the latter be lifted too high, is really almost unnecessary.

The hammer is intended to forge steel. The guides are of wrought iron, and are bolted to heavy plates of iron fixed to the upright frames.

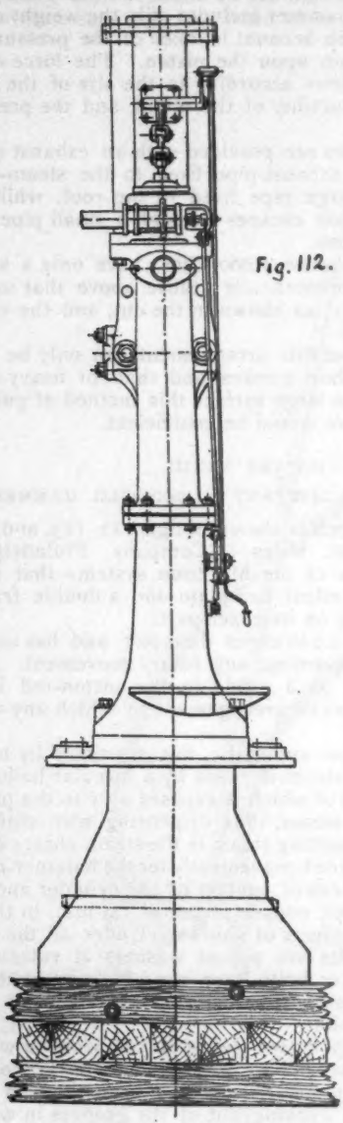


Fig. 112.

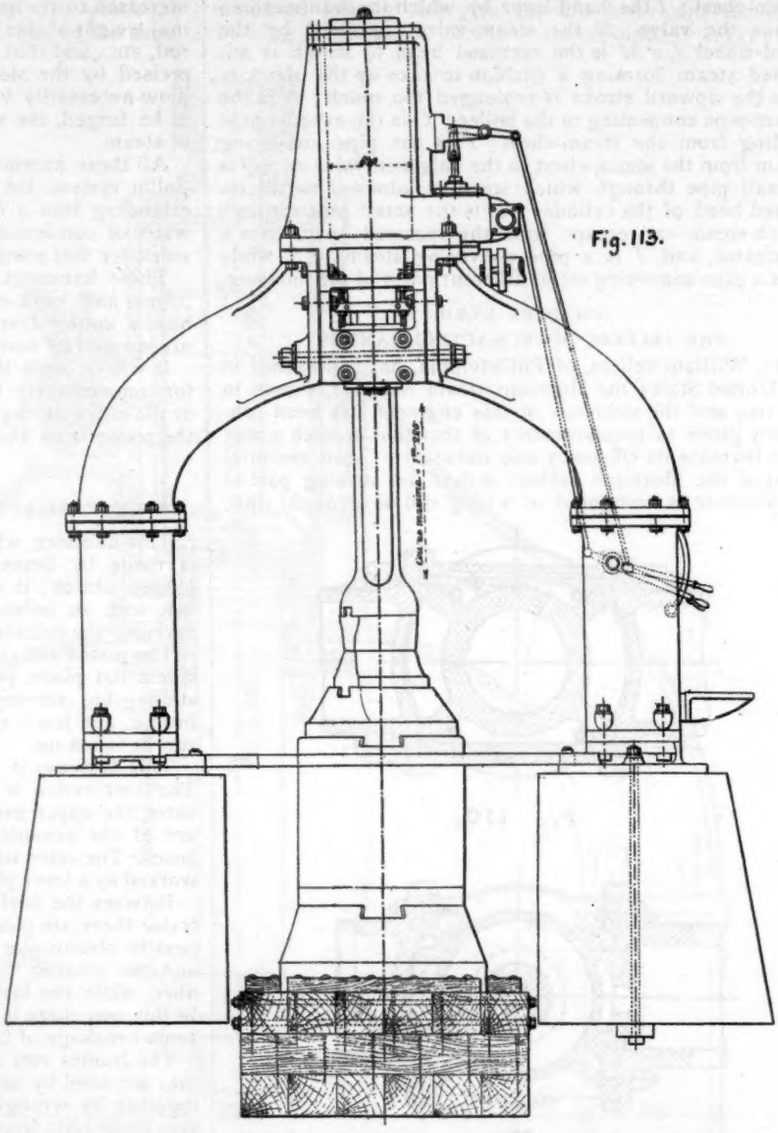


Fig. 113.

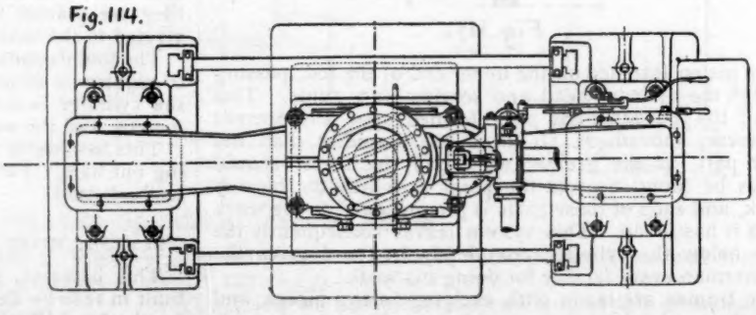


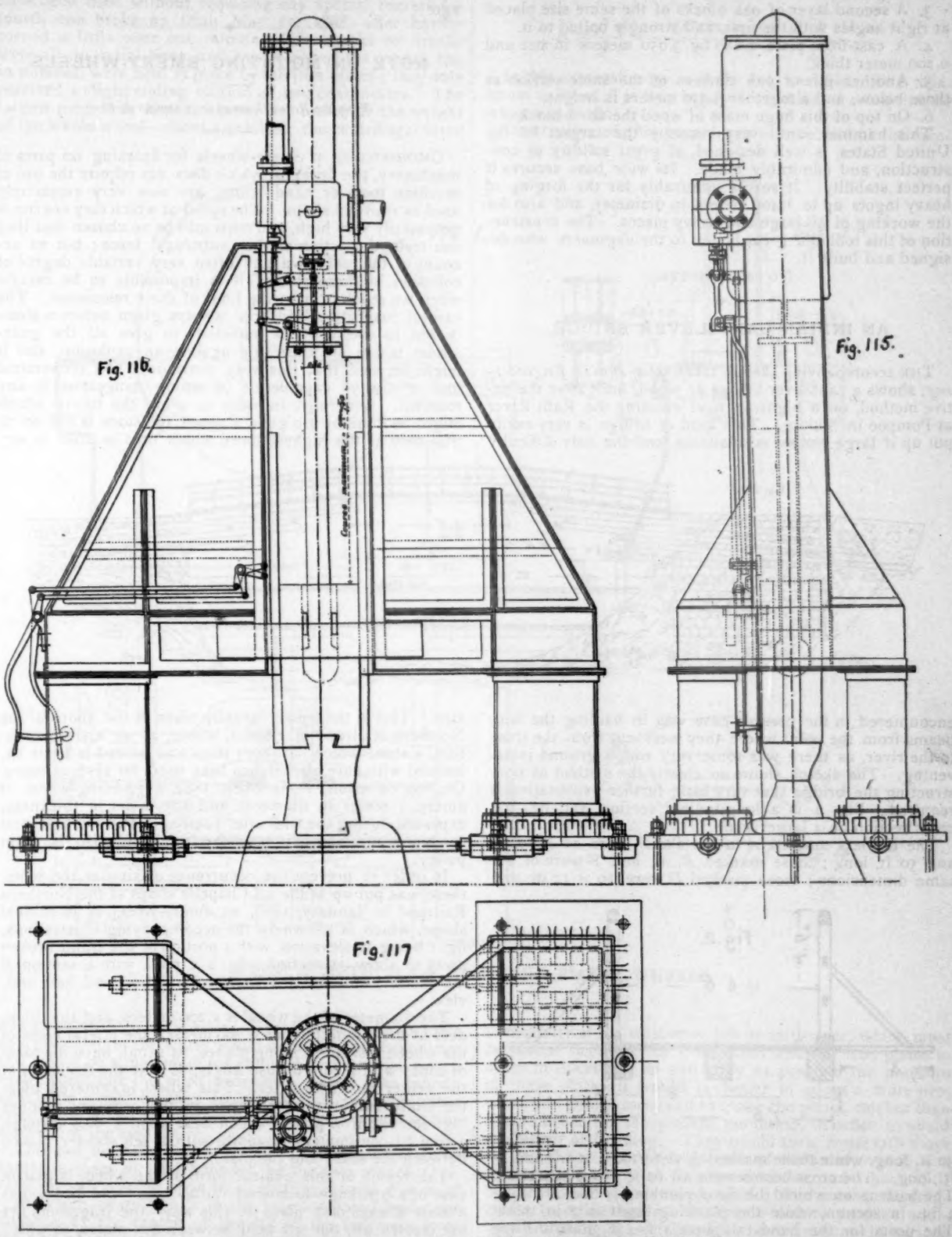
Fig. 114.

BEMENT, MILES & COMPANY'S 2,700-KILO. HAMMER.

The plates of the frames are 28 mm. thick, those of the girders 21 mm., and those of the upper frame 15 mm. All the joints of the plates are planed, in order to obtain a perfect fit. The rivet-holes, the diameter of which is 30 mm., are countersunk and the rivet-head is joined to the body with a fillet of 5 mm. radius. The legs rise two by

two on a huge mass of cast iron, which in its turn is bolted down to a heavy masonry foundation. These two cast-iron blocks are joined together by two bolts 0.110 meter diameter placed on each side of the anvil block.

fiber 6 mm. thick. This fiber has the color and appearance of leather, and is said to last as well as oak wood. The anvil, the weight of which is 1,050 kilos., has the form of a truncated pyramid with a rectangular base,



BEMENT, MILES & COMPANY'S 15,500-KILO. HAMMER.

To avoid the breakage of the numerous bolts employed in the construction of this hammer, there are placed under the nuts and bolt-heads washers of vulcanized

and was cast in place. The casting took 4½ hours, and the block was left six weeks in the sand before it was cleaned off.

The foundations were made with great care and in the following way:

1. A bed of concrete.
2. A layer of oak blocks 6.700 meters long and 0.360 meter square.
3. A second layer of oak blocks of the same size placed at right angles with the first, and strongly bolted to it.
4. A cast-iron plate 4.880 by 3.050 meters in size and 0.200 meter thick.
5. Another pile of oak timbers of the same section as those below, and altogether 3.350 meters in height.
6. On top of this huge mass of wood the anvil-block.

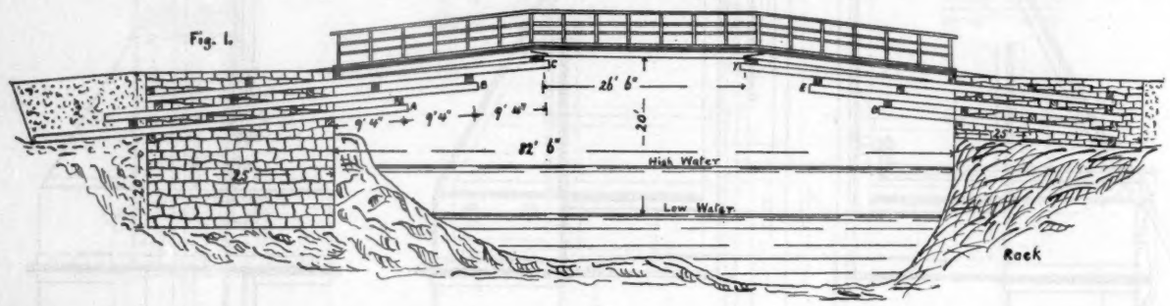
This hammer, until very recently the largest in the United States, is well designed, of great solidity of construction, and admirably made. Its wide base secures it perfect stability. It serves admirably for the forging of heavy ingots up to 1.400 meters in diameter, and also for the working of all large and heavy pieces. The construction of this tool did great honor to the engineers who designed and built it.

(TO BE CONTINUED.)

AN INDIAN CANTILEVER BRIDGE.

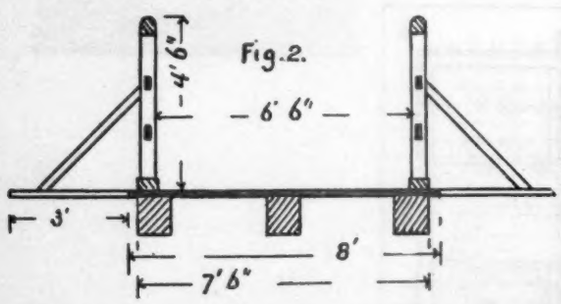
THE accompanying sketch, taken from *Indian Engineering*, shows a cantilever bridge of wood, built after the native method, on a highway road crossing the Rahi River at Pompoo in Sikkim. This kind of bridge is very easily put up if large timber is available, and the only difficulty encountered in the present case was in hauling the long beams from the point where they were cut from the trees to the river, as there was some very rough ground intervening. The sketch shows so clearly the method of constructing the bridge that very little further explanation is required. Fig. 1 is a longitudinal section, and fig. 2 a cross section on a larger scale.

Fig. 1.



The timbers marked *A* in the sketch were 12 × 10 in. and 50 ft. long; those marked *B*, *C*, and *Y* were of the same dimensions; those marked *D* were 10 × 12 in. and

Fig. 2.



32 ft. long, while those marked *E* were 10 × 12 in. and 42 ft. long. The cross beams were all 10 × 12 in. in section. The battens on which the floor planking is laid are 2½ × 4 in. in section, while the planking itself is 2 in. thick. The posts for the hand-rail were 4 × 4 in. stuff, the top rail being 3 × 5, and the lower rails 2½ × 3½ in.

The bridge was put up at high water, but no scaffolding or false-work was required. The wood used for the large timbers was an Indian wood, called *Sal*.

As showing how unchanging methods are in that part of the world, it may be of interest to compare this drawing with the engraving of an Ancient Cantilever Bridge, which was published in the JOURNAL for June, 1888, page 269, which shows that this type of bridge as used in that country is substantially the same now as it was over 200 years ago.

NOTE ON MOUNTING EMERY-WHEELS.

(From the *Revue General des Chemins de Fer.*)

GRINDSTONES or emery-wheels for finishing up parts of machinery, the fitting of which does not require the use of machine tools or hand-fitting, are now very extensively used in railroad shops. The speed at which they are run is necessarily very high, and must still be so chosen that they can resist the action of the centrifugal force; but on account of the unknown and often very variable degree of cohesion in these stones, it is impossible to be certain when we reach or pass the limit of their resistance. The careful inspection and trial always given before a stone is put in use are not sufficient to give all the guarantees which are desirable against an explosion, and it might be said that this very convenient and economical tool is always capable of becoming dangerous at any moment. Generally, in order to avoid the injury which might be done by too great a speed, the stone is run on its trial only at the highest speed which is to be used in service. This is the course usually taken in the shops of the Northern Railroad of France, where, as an extra precaution, a stone which has been tried and passed is again examined with care after it has been used for several hours. On one occasion, in October, 1884, a grinding-wheel of emery, 1 meter in diameter and 0.20 meter in thickness, exploded during the trial after running for 18 minutes, and the pieces thrown off injured the frame and also the main pulley.

In order to prevent the occurrence of similar accidents, there was put up at the La Chapelle shops of the Northern Railroad in January, 1886, an emery-wheel of bi-conical shape, which is shown in the accompanying illustrations, fig. 1 being an elevation, with a portion of the frame broken away to show its section; fig. 2 a plan, with a section of the wheel; and fig. 3 a half cross-section and half end-view.

The diameter of the wheel is 1.200 meters, and the thickness at the circumference 0.200 meter; the lateral faces of the wheel, instead of being planes, as usual, have the form of cones with a very obtuse angle, so that the thickness at the center is 0.230 meter. This wheel is centered upon the shaft, and is then clamped in the ordinary manner between two iron plates, which bear upon it only through a ring 10 centimeters in width, with a felt washer placed between the stone and the plate.

The result of this conical form of the wheel is that in case of a breakage following radial lines—and breakages almost always take place in this way—the fragments are not thrown off, but are held between the plates, to which there is given for greater safety a large diameter, in the case described two-thirds that of the wheel. When the wheel is worn down to a certain degree, these plates are replaced by others, somewhat smaller but having the same conical form, and this permits the limit of wear of the

wheel itself to be reached ; by a change of the driving pulley, made at the same time as that of the plates, the speed of the circumference of the wheel can be kept the same.

Three emery-wheels like that which we have described have been used without requiring any special remark ; a fourth one broke on trial, May 15, 1888, after having turned a little over one minute. The cracks or breaks were all on radial lines, and the pieces of the wheel, five in number, were held in place by the iron plates ; they only received a slight sliding motion of two centimeters. The largest piece was almost exactly one-fourth of the weight of the whole wheel—about 130 kilos.; the centrifugal force was calculated at 7.800 kilos. The intensity of this force on a fragment of the wheel would increase with its volume, and would be a maximum for one-half of the wheel, which would constitute the most dangerous piece. The centrifugal force would be then 10.800 kilos., if we admit that there was no radial friction between the sections at the moment of the rupture.

This can be easily demonstrated. A fragment of stone having a mass m, and bounded by the two planes $O A$, $O A'$ (fig. 4), is acted upon by a centrifugal force $F = m x^2 r$, in which expression x is the angular speed and r the distance of the center of gravity of the fragment from the axis of rotation. If we designate by $2 a$ the angle $A O A'$, and by P the weight of the stone, we have :

$$m = \frac{P}{g} \times \frac{2 a}{2 \pi} = \frac{P a}{g \pi}$$

Then let R be the radius of the circle passing through the center of gravity of the fragment, and we have :

$$r = R \times \frac{\text{Chord } B B'}{\text{Arc } B C B'} = R \times \frac{2 R \sin. a}{2 a R} = \frac{R \sin. a}{a}$$

The value of the centrifugal force then becomes :

$$F = \frac{P a}{g \pi} \times \frac{x^2 R \sin. a}{a} = \frac{P x^2 R \sin. a}{g \pi}$$

In this expression sin. a is the only variable. The maximum value of F is then reached when sin. $a = 1$ —that is, when $2 a = 180°$.

On account of this considerable force and of the compressibility of the washer of felt or soft paper, which must be placed between the stone itself and the iron plates in order to distribute as uniformly as possible the pressure of these plates, it would be better to adopt a more pronounced conical form and to make the plates thicker than those chosen for the present mounting, in order to avoid all danger of bending. They would then resist still more the radial force of the fragments of the stone, which was produced on the trial mentioned above, and which, if it had been more pronounced, would have caused the fragments to strike against the frame and to produce additional breakages, which might have resulted in serious accidents.

By the use of this system of bi-conical stones mounted with care, and by considering the observations which we have presented, all serious danger and injury during the trials of a stone may be avoided and almost complete security obtained in its working.

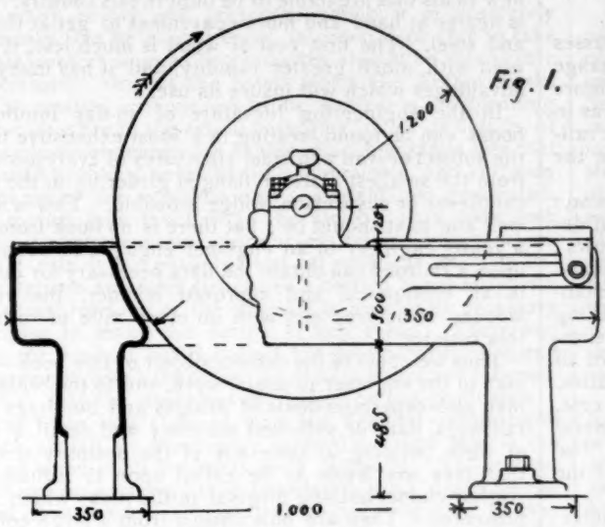


Fig. 1.

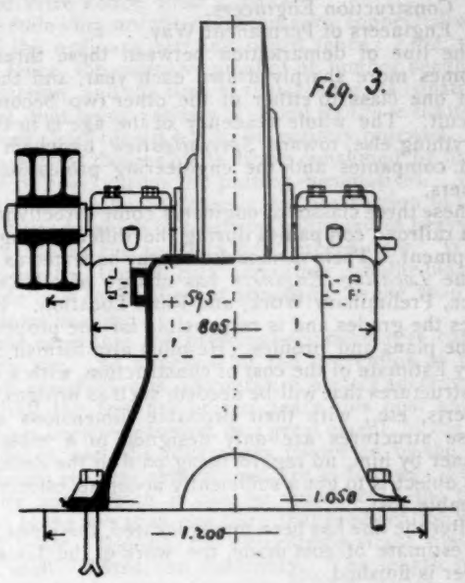


Fig. 3.

Dimensions in millimeters.

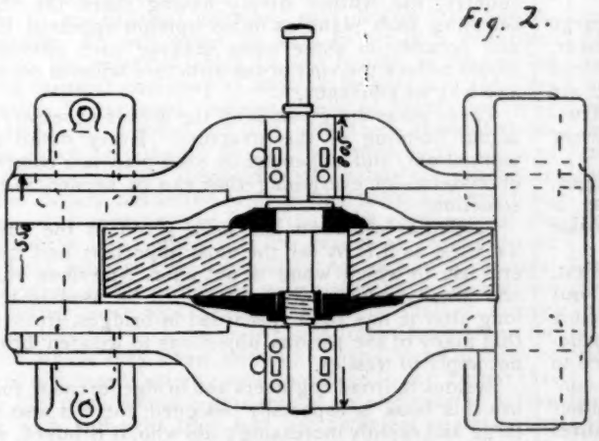


Fig. 2.

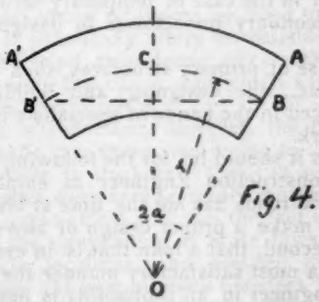


Fig. 4.

FRENCH METHOD OF MOUNTING EMERY WHEELS.

THE USE OF WOOD IN RAILROAD STRUCTURES.

By Professor C. D. Jameson.

(Copyright, 1889, by M. N. Forney.)

CHAPTER I.
INTRODUCTORY.

The Railroad Engineers of to-day may be divided in regard to their duties about as follows:

1. Locating Engineers.
2. Construction Engineers.
3. Engineers of Permanent Way.

The line of demarkation between these three classes becomes more sharply drawn each year, and the change from one class to either of the other two becomes more difficult. The whole tendency of the age is in this, as in everything else, toward *Specialization*, by which the railroad companies and the engineering profession are the gainers.

These three classes of engineers come directly in contact with railroad companies during the different stages of development. Their various duties may be stated as follows:

The *Locating Engineer* has charge of all Reconnaissance, Preliminary Work, and Final Location. He establishes the grades and is responsible for the proper making of the plans and profiles. He must also furnish a Preliminary Estimate of the cost of construction, with a list of all the structures that will be needed, such as bridges, trestles, culverts, etc., with their probable dimensions and cost. These structures are only designed in a most general manner by him, no regard being paid to the details. The only object is to get a sufficiently accurate estimate of the probable cost.

After the line has been finally located, the plans, profiles, and estimate of cost made, the work of the Locating Engineer is finished.

From that point the *Construction Engineer* takes charge of the work. The duties of the Construction Engineer, either directly or indirectly, are not only to superintend the building of the road and of all the structures that are needed, but in the case of temporary structures or structures of secondary importance to design them in every detail.

In the case of primary structures, such as iron bridges, viaducts, etc., the designing and building of these is usually placed in the hands of specialists in this particular class of work.

This is as it should be, for the following reasons: First, that the Construction Engineer as employed upon our American railroads has not the time at his disposal that is required to make a proper design of any elaborate structure, and second, that a man that is in every way fitted to perform in a most satisfactory manner the duties of a construction engineer in all probability is not fitted by either education or training for the designing of large structures in iron or steel.

But there is a large class of structures not only the erection but the designing of which in all their details comes in the hands of the Construction Engineer, such as road-crossings, small culverts, cattle-guards, water-tanks, small stations, and so on up through wooden trestles and wood-and-iron bridges. Such structures as these have to be designed in every detail by the Construction Engineer, are built under his supervision, and erected by him.

It therefore becomes eminently necessary that he should have a thorough understanding of the necessities of such structures and be in every way capable of making such designs as are required; be able not only to design structures that shall have sufficient strength to bear up any possible load that may come upon them, but also that he shall be able to get a maximum amount of strength from a minimum amount of material used. The same may be said of the Engineer in charge of the Permanent Way. Although the road is supposed to be complete when it comes into the hands of the Department of Permanent Way, still in a majority of cases, in this country at least, it is far from being finished, and many of the structures upon it are only temporary structures, which it becomes necessary to replace in a few years. When they are replaced the new structures are supposed to be improvements on the old ones, both as to the strength and economy of material used. Thus the Engineer of Permanent Way must of necessity understand the designing of ordinary wooden bridges and other structures that come in his way.

Of course the use of wood in railroad construction is diminishing year by year as the price of iron and steel decreases, but with all this decreased cost of metal it is still true that from 50 to 70 per cent. of all the bridges built in the United States each year are built of wood, and designed and erected by the engineers on the road; and for many years to come this is sure to be the case on all the new roads that are liable to be built in this country. Wood is nearer at hand and more convenient to get at than iron and steel. The first cost of wood is much less, it can be used with much greater rapidity, and it has many other advantages which will insure its use.

In the engineering literature of to-day innumerable books can be found treating in a most exhaustive manner the subject of iron and steel structures of every dimension, from the smallest plate or flanged girder up to the largest cantilever or suspension bridge probable. This is all very well and as it should be; but there is no book from which a young engineer or an engineer engaged in actual work upon a railroad can obtain the data necessary for building, in an economical and approved manner, the ordinary wooden structures met with on every mile of railroad in this country.

Thus we come to the definite object of this book—to furnish to the engineer in actual work, and to the bridge foremen and superintendents of bridges and buildings on our railroads, data of sufficient accuracy and detail to permit of their building at once any of the ordinary structures that they are liable to be called upon to furnish. The Author claims nothing original in the plans which will be presented. They are only chosen from a large collection of standard plans of most of the leading roads in the country, the Author simply having taken the liberty of selecting such plans as in his opinion appeared the best, and possibly in some cases making such alterations as would reduce the cost of the structure without reducing in any way its efficiency.

These plans are given in all the details necessary for the actual building of the structure. Every detail is fully worked out, and appended to each plan is a complete bill of material of everything that can be needed in the construction.

Particular attention has been given to the subject of Trestles, as it is by far the most important and most general use to which wood is put upon American railroads, and it will undoubtedly continue to be used in this form long after it has been discarded in bridges, from the fact that many of the serious objections to wooden bridges do not apply to trestles.

Besides railroad engineers and bridge foremen, for whose use this book is especially designed, there is also another large and rapidly increasing class who, it is hoped, will find it of great use, and that is the class of young engineers or students who are preparing themselves for regular work. In all our technical schools too much time is spent upon the designing of details and the study of the construction of tremendous cantilever and suspension bridges. Not one out of a thousand of the students who graduate as engineers will ever be called upon to build structures of this vast size.

While it is all important that in order to round out and finish their preparatory engineering education, they should thoroughly understand the principles upon which the construction of such bridges is based, still it appears to the Author that in spending a whole year or more in studying out the details much valuable time is wasted, and the student gets very little benefit from it. The course of engineering, as taught in our American schools, is at the most only four years in length. The students enter the course with no better, and often with much less preparation than is required for an ordinary scientific or classical course.

At the end of the classical course the student then enters a law or medical school, as the case may be, and studies

his profession for two or three years. At the end of that time he is considered fit to become either a doctor or a lawyer, thus having put some seven years into acquiring his knowledge, while in the Department of Engineering four years is the limit, and at the end of that four years the student is expected to have acquired not only a good general education, to be well grounded in all subjects of general information, but also to have completed in as thorough a manner as possible a special course in Engineering. In order to do this in a satisfactory manner it increases by 75 per cent. the amount of work that must be done each year by the student, and it also devolves upon the instructor to use much care in eliminating from this course anything that can, without loss to the student, possibly be postponed until after he is in actual practice, in order that the many points and principles which it is absolutely necessary that he should know, in order to be able to take up his work as soon as he graduates, should be thoroughly understood. One of the points which the Author thinks can be omitted without loss to the student is the spending a year or more in the actual designing, in all its details, of a cantilever or suspension bridge of such gigantic size that it would probably never be built in practice, and certainly never under the supervision of a student just graduated. No matter how much time the student puts upon such work, it always contains more or less radical defects which would rule it out entirely from all practical use. In designing iron and steel structures a certain familiarity with the actual working of the material is absolutely necessary in order to make the design of any value. Therefore, after the student has mastered the general principles and theory upon which the designing of such structures is based, let him drop the structures until after he has graduated.

But there is a class of work the detailed designing of which should be thoroughly understood, and that is the use of wood in all its forms upon railroads. The student must not only have a broad foundation upon which he can build up any special branch of engineering that he may choose after he graduates, but he must also know enough of the practical details of work to make himself of some value to any railroad company that desires his services. Otherwise, he will never be able to retain a situation. And as the material which he will handle in the employ of any railroad company as soon as he gets into the Construction Department or Department of Permanent Way will be wood, or wood and iron combined, in small structures, much time should be spent in studying the plans of these structures and thoroughly grounding the student in all the details connected with their design and erection. There is a constant cry from the chief engineers of the railroads in this country that the graduates from our best technical schools have absolutely no idea of a practical application of the principles which they have been studying during their four years, that they are full of theory, or, in other words, have their hands full of tools about the use of which they know nothing. The Chief Engineer of one of our best Western roads remarked to the Author that "he had never found a graduate of an engineering school who with sufficient time had not sufficient mathematics and theory to permanently locate the position of a star, but he also found very few who had sufficient practical knowledge or common sense to locate a switch or a curve." And this is very much the case.

This book is written, then, as much for the student as for the engineer in practice. By a careful study of its pages it is hoped that he will get a thorough understanding of all the details of any structures which he is liable to be called upon to build, certainly within the first 10 years after his graduation. If the time ever comes that he is called upon to span the Mississippi or the Hudson, it will be so far distant from his college days that he will have had plenty of time to perfect himself in the knowledge necessary for the proper consummation of the work.

CHAPTER II.

FENCES.

In most parts of the United States, and, in fact, in most parts of the civilized world, the railroad companies are required by law to construct and maintain upon each side of their line of road, usually upon the lines of their right-of-way, some class of fence, of such a character as will prevent any live-stock that may be running upon the adjacent land from crossing the track or in any way impeding the free passage of trains, on account of the great element of danger introduced thereby.

The class of fence that can be used is not, in many States, left to the discretion of the railroad companies, but there is a State law definitely designating exactly what manner of fence shall be used. In other States the law merely requires that the fence shall be suitable and in every way answer the purpose for which it was intended.

There are only two classes of standard fence used to any great extent by railroads in this country. These are the ordinary Board and Post Fence, Plate I, fig. 1, and the Barbed Wire Fence, Plate I, fig. 4.

The following are the disadvantages connected with the use of the ordinary post and board fence: First, the cost of the fence, the excessive amount of lumber needed in its construction, and the time it requires for its construction. Second, that being entirely of wood its life is limited, and in a very short time it has to be entirely renewed. There is also a great danger of its being consumed by fire occasioned by sparks from the passing locomotives. The last objection to the board fence is the obstruction to the passage of winds which in countries subjected to heavy snows always causes the snow to drift exceedingly. Where it occurs at the top of cuts and other similar places it is liable to be a cause of great annoyance to the road during the winter season.

These constitute the principal disadvantages connected with its use. As a means for the prevention of the passage of live-stock it is, of course, a perfect success.

During the last five or ten years this post and board fence has been superseded, to a great extent, by the barbed wire fence, and the advantages possessed by the barbed wire fence are very evident, and are as follows: First, the rapidity with which it can be constructed, the time required being less than one-third that required for post and board fence. Second, the exceedingly slight cost of material used. Third, the durability. The length of life of the barbed wire fence depends almost entirely upon the life of the posts. If care is taken when selecting the wire to choose wire of soft material and of sufficient elasticity not to be affected by the expansion and contraction due to changes of temperature, and also wire that has been properly galvanized, there is almost no limit to its durability as a fence. It practically offers no resistance to the free passage of the wind, thus doing away with all the objections arising from this cause, and which are so prominent in the post and board fence.

In its first introduction, however, the barbs upon the wires were made very sharp, and owing to the fact that the fence is invisible to stock until they run against it, many valuable animals were very seriously injured and cut by it.

To such a great extent was this the fact in some States, that it led to the establishing of State laws prohibiting its use in certain localities, and aroused much prejudice against it upon the part of stock breeders living upon the line of railroads where it was used. This prejudice, however, has been done away with, to a great extent, at the present time. In the first place, people are becoming accustomed to its use, and also the barbs on the wire, as now manufactured, are not sufficiently sharp to seriously injure any stock running against it.

Plate I, fig. 4, shows two methods of construction of the ordinary Barbed Wire Fence.

In order to do away, to a certain degree, with the fact that the fence is not readily seen by stock until they run against it, the top strand is very often removed and replaced by a piece of scantling, as shown in the right hand of the drawing. This renders the fence perfectly visible to the stock, and only increases the expense to a slight extent.

In the ordinary board fence, as shown in the drawing, the posts should be about 7 ft. long and 6 in. in diameter. The bark should be removed, as it very soon dries and becomes a great element of danger from fire. In order to obtain the best results with the ordinary post and board fence, the post-holes should be excavated to nearly their full depth and the earth thoroughly tamped around the posts after they are set in position.

St. J. & I. R.R. No. 1.

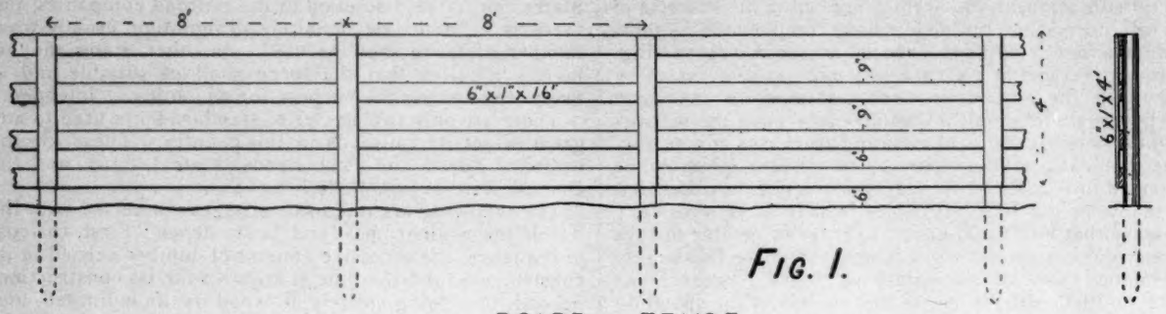


FIG. 1.

BOARD FENCE

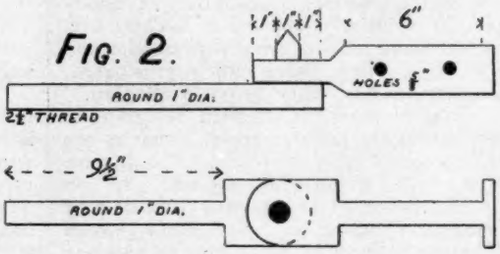
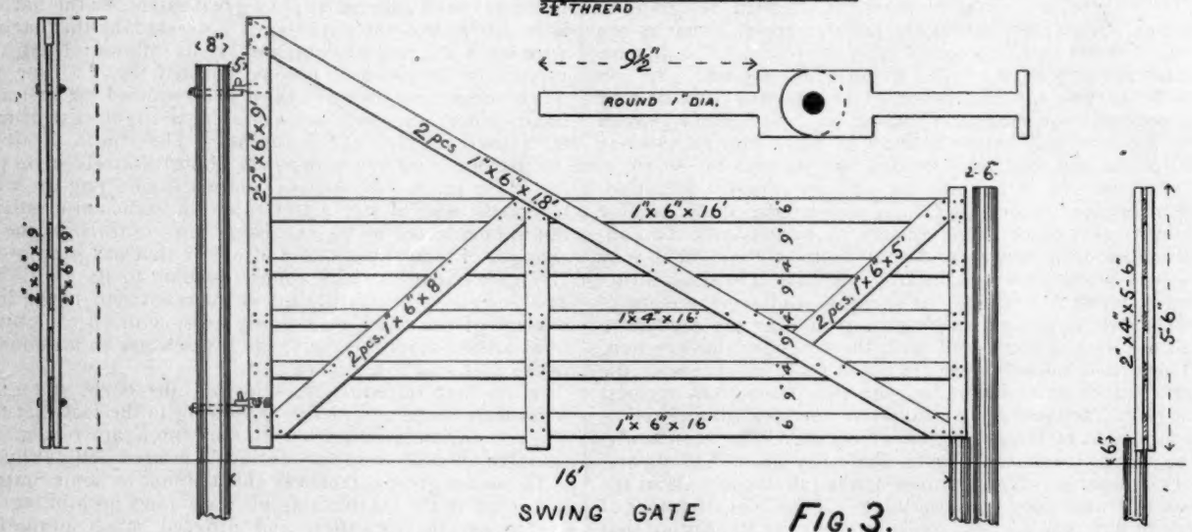


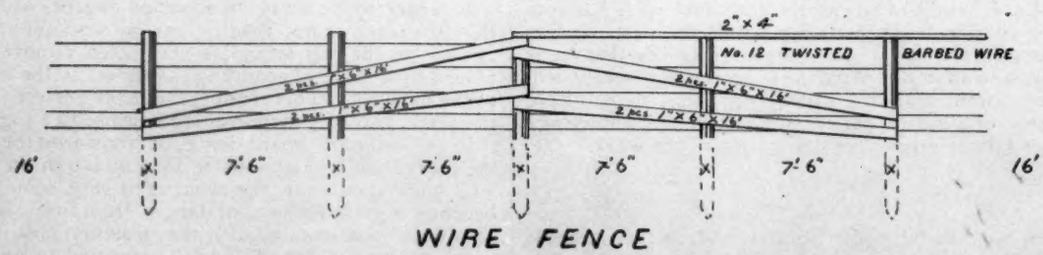
FIG. 2.



SWING GATE

St. J. & I. R.R.

FIG. 3.



WIRE FENCE

C. M. & St. P. R.R.

FIG. 4.

The posts should be 8 ft. apart from center to center, as the standard length of the boards is 16 ft.

On most roads, however, it is the custom to simply point the posts and drive them by means of a heavy maul to the required depth, and perhaps a compromise between these two methods would be the most economical as to the time and the stability of the posts—that is, excavate the post-hole one half the required depth, then drive the post the remainder of the distance, and tamp the earth solidly around it.

The boards should always be fastened upon the field side of the posts, in order that the posts may take any strain due to stock running against the fence, and not throw this strain upon the nails by which the boards are held.

Upon the outside of the fence it is usual to put a piece of batten 1 in. × 6 in. × 4 ft. over the ends of the boards, and nail directly through this into the posts. This only adds slightly to the cost of the fence and increases its durability very much.

The ordinary height for a board fence is 4 ft. 6 in. from the ground. The first board, as shown in the drawing, should be at least 6 in. from the ground, the space between that and the second board 6 in., and the other spaces greater—about 9 in. The object of this is to prevent the passage of small live-stock, in the shape of pigs, etc., through the fence.

The following is a bill of material required for the construction of one mile of ordinary post and board fence :

No. 1. Bill of Material, Board Fence, 1 Mile.

660 posts.
1,320 boards..1 in. × 6 in. × 16 ft...10,560 B. M.
660 battens...1 in. × 6 in. × 4 ft... 1,320 B. M.
250 lbs. nails.

Another advantage connected with the use of the barbed wire fence is the fact that the posts need be no nearer than 16 ft. from center to center, thus requiring for a given distance only half the number of posts required for an ordinary post and board fence. This distance of 16 ft. should always be adhered to when possible, from the fact that if from any reason it should become necessary to replace the barbed wire fence by an ordinary post and board fence, then these posts could be used and the others simply introduced in the spaces between, making the panels 8 ft. long, while if they are put 9, 10, or 12 ft. apart, they are not properly spaced for the ordinary boards that are 16 ft. long.

As shown in the drawing, about every quarter of a mile the posts should be braced by means of two braces each way, 1 in. × 6 in. × 16 ft. long.

After the posts have been put in the ground, the manner of constructing the barbed wire fence is simply by fastening all the wires to one of the posts that are braced and then stretching them, by means of a properly constructed wrench, tightly from post to post, and fastening them.

The height of a barbed wire fence is about the same as the ordinary post and board fence, and five strands should always be used, unless a piece of batten is used for the top, when four strands are sufficient.

The strands of wire coming near the bottom should be placed nearer together than at the top, for the same reason that the boards in the post and board fence are nearer together at the bottom.

Although in some sections the prejudice against barbed wire fences is still very strong, there is no doubt that, as the price of wood increases and the price of barbed wire decreases, barbed wire, or some class of metal fence, will be the fence of the future.

As was said before, the life of a barbed wire fence, or any metal fence, depends to a great extent upon the life of the material that is used for the posts, and thus much more money can be economically spent in obtaining good cedar posts for the barbed wire fence than would be justifiable in the ordinary post and board fence.

In some parts of the West experiments, to a very limited extent, have been made with a view to using posts made of terra cotta. Provided the posts could be made sufficiently strong to bear the cross strain that may come upon them, and still light enough to be easily handled, it would present an almost ideal fence post, from the fact that terra cotta is practically indestructible, as far as climatic influences are concerned. As yet, these experiments have been carried to such a slight extent that we are not in any way able to judge what the ultimate results may be.

Through England and in many parts of Europe the fences along each side of the railroads are replaced by means of well-kept hedges. These hedges, of course, are very effective in barring the passage of stock, and also from a picturesque standpoint; but they require constant care, take up a great deal of space, and from a practical standpoint are no better than the ordinary barbed wire fence, so that there is very little probability of their ever being introduced to any great extent in this country, although at present upon some of the Eastern roads they have been used to a slight extent in connection with small stations, but only carried a short distance each side of the station, and used purely for the purpose of ornamentation in connection with flower-beds and lawns that have been laid out at many of these stations.

The following, No. 2, is a complete bill of material for the building of one mile of standard barbed wire fence with five strands. No. 3 is a bill of material of a barbed wire fence of four strands with wooden rail at the top; and No. 4 is a bill of material for the standard Swing Gate, as shown in the drawing.

No. 2. Bill of Material, Wire Fence (5 Strands), 1 Mile.

338 posts.
32 pcs.....1 in. × 6 in. × 16 ft. 256 B. M.
26,400 ft. wire..0.8 lb. per ft.....21,120 lbs.
70 lbs. staples.
7 " 10d. nails.

No. 3. Bill of Material, Wire Fence (4 Strands and Wooden Rail at Top), 1 Mile.

338 posts.
32 pcs.....1 in. × 6 in. × 16 ft. 256 B. M.
320 " .....2 in. × 4 in. × 16 ft. 3,520 B. M.
21,120 ft. wire.0.8 lb.....16,896 lbs.
60 lbs. staples.

Plate I, fig. 3, shows the ordinary Swing Gate. This gate is always built of wood, no matter what class of material is used for the construction of the fence. The principal thing to be considered in building a gate is that the hinge-post should be firmly set in the ground, in order to do away with all danger of sagging upon the part of the gate. This form of gate shown, which is the standard upon the St. Joseph & Iowa Railroad, is no more expensive and much more durable and satisfactory in every way than the ordinary farm gate, where the hinges are only placed about 4 ft. apart, cutting off the hinge-post at the height of the fence. The increased expense incurred by running up the back of the gate to 9 ft. and thus increasing the bearing upon the hinges is very slight, and is more than compensated by the increased stability of the gate.

The following is the bill of material for one gate, as shown in Plate I, fig. 3 :

No. 4. Bill of Material, Swing Gate.

1 guard rail for hinge post and snubbing post.....6 in. × 8 in. × 16 ft.
1 fence post for latch post..10 ft.
2 pcs.....2 in. × 6 in. × 9 ft.
2 " .....1 in. × 6 in. × 18 ft.
2 " .....1 in. × 6 in. × 16 ft.
2 " .....1 in. × 6 in. × 8 ft.
2 " .....1 in. × 6 in. × 6 ft.
2 " .....1 in. × 6 in. × 5 ft.
3 " .....1 in. × 4 in. × 16 ft.
2 " .....2 in. × 4 in. × 6 ft.
3 lbs. 40d. wrt. nails.
3 " 10d. " "
1 pair hinges as per fig. 2, with nuts and washers.
4 bolts ½ in. × 6 in. (Machine) with nuts and washers and 1½ in. thread.
1 heavy hook and staple.

Plate I, fig. 2, shows in detail the standard form of hinges to be used upon these farm gates. Any ordinary blacksmith can make them in about two hours' work.

(TO BE CONTINUED.)

THE HURST & TREANOR STONE CAR.

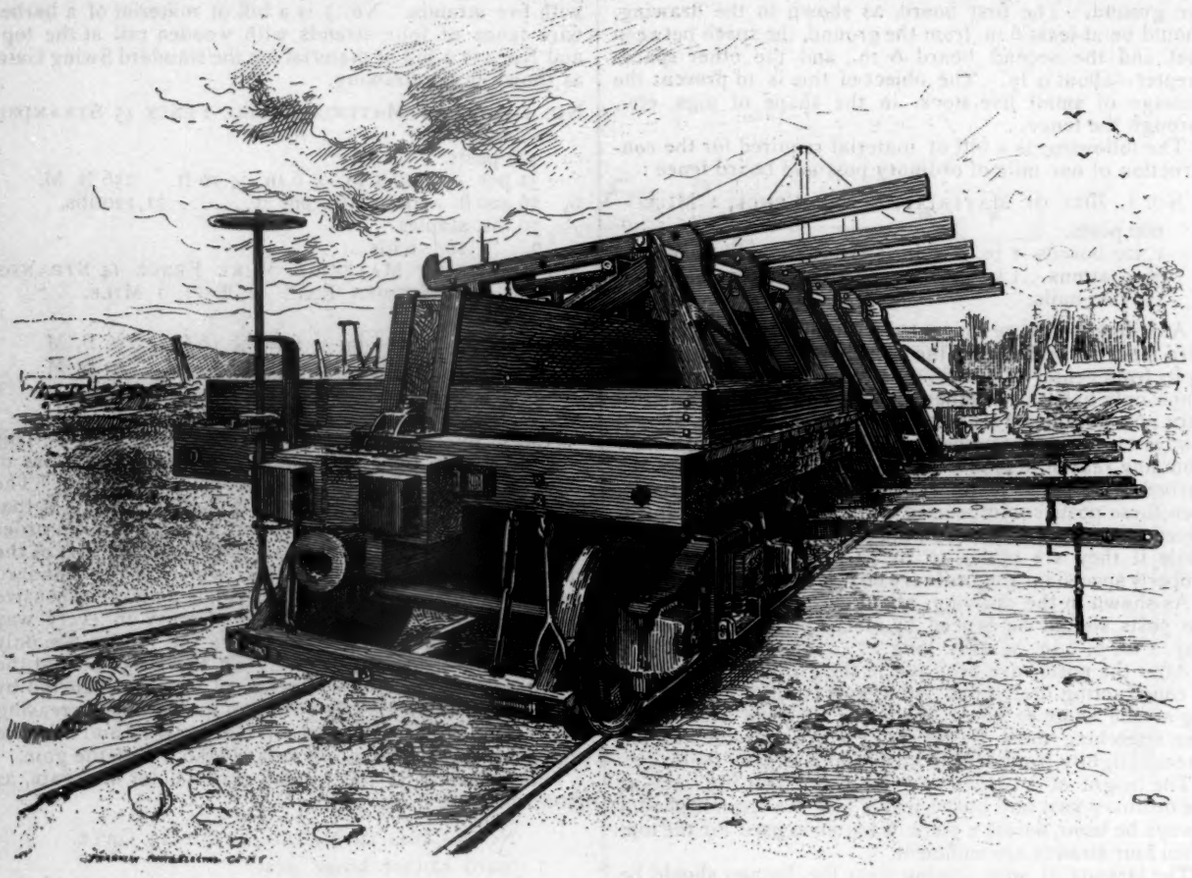
THE accompanying illustrations show a car intended to carry paving-stones of very large size, one of them being taken from a photograph of the car loaded, while the other shows the car empty, exhibiting the method of its construction. This car was designed by Mr. James J. Treanor, of the firm of Hurst & Treanor, blue-stone dealers at Hastings, N. Y., with the intention of overcoming one of the chief difficulties in the way of transporting large stone platforms by rail. On an ordinary flat car no stone larger than 10 ft. in width can be carried, and this size is not sufficient for those now used for sidewalks on the principal avenues in New York, where the preference is for single stones extending from the stoop line of the house to the curb line or outer edge of the walk. This distance is usually 15 ft. 6 in., and stones 15 ft. 6 in. or longer, by 10 ft. wide, have been carried to the city by rail. Many of the larger and handsomer houses in the city, however, have stoops varying in width from 10 to 20 ft. between the newel-posts, and it is always desirable to cover this space with a single stone. Hence the problem arose how to carry a stone 15 ft. 6 in. wide and from 10 to 25 ft. long, when required.

Mr. Treanor made sketches of his plan and submitted them to Mr. William Buchanan, Superintendent of Motive Power of the New York Central & Hudson River Railroad, and under his direction the car was built by Mr. E. Chamberlain, Master Car-Builder at the car shops in East Buffalo.

The car is built with two ordinary standard trucks, set about 35 ft. from center to center, the portion over each truck being framed and floored the same as an ordinary platform car. These platforms are connected by a heavy pine girder 12 × 24 in. resting on top of them, and extending from one end-sill to the other. This girder acts as an immovable beam, serving also as a rigid backbone for the support of six oak triangles, each 6 ft. on the base and about 6 ft. on the perpendicular. These triangles are framed so that they straddle the girder or backbone, their sides extending to the line of the oil-boxes on the car trucks, and their bases coming down to within 14 in. of the top of the rail. Under the bases four truss-rods are strung; the two outer ones are attached directly to the end-sills, and lead down from them to the under side or base of the triangles, having the effect of putting down the ends of the car when the load is in position, and thus preventing sagging. The other two also run under the bases, but are attached to the inside end-sills so that their pull is against the strains of the outer truss-rods.

The triangles carry each at its upper apex a heavy cast-iron cap, and through these caps runs an iron shaft 2½ in. in diameter, extending from end to end of the car. The extremities of this shaft rest on braces built upon the end platforms. This shaft serves as a bearing for straps of 6 × 1½ in. iron, bent as shown in the accompanying sketch (fig. 3), the lower end of each strap having a hook projection, on which the edge of the stone rests. These straps are placed in couples, with an oak skid 5 × 6 in. bolted between each pair, these skids being flush and parallel with the lower portion of the straps, and extending above them as a support for the top portion of the stone when loaded. The straps are bent at such an angle that when they are placed in position on the shaft—on which they simply hang by the circular slot cut in the angle at *B*—their lower edges rest against the triangles described above. In the horizontal position the straps are bored at their outer ends to permit an iron pin to pass through them and through upright iron rods, which are fastened to the triangles on the side opposite to the load. These upright rods act as braces when the load is top-heavy, and as tie-rods at other times.

To load the car the straps are turned on their bearings until the hooked parts and the skids which are bolted to



HURST & TREANOR'S CAR FOR CARRYING LARGE STONES.

them are in a horizontal position, and are then blocked to prevent them from falling. The stone is then rolled on to the skids until the edge comes against the hooks, the blocking is taken out, and the stone, which is then like the leaf of a table hung in the middle, is lowered until the ends of the skids rest on the triangles. A bar of railroad iron is passed through two eye-bolts which are tightened by turn-buckles until the bar is pressed hard against the face of the stone, thus locking it in place so that it cannot be jarred off the hooks. The car is then ready to be started on the road.

The stone that this car was built to carry was not the largest that ever came to New York, but it was yet the largest by 4 ft. 8 in. that ever came by rail. On this car a stone can be carried 26 ft. long by 15 ft. 4 in. wide without interfering with the tunnels or bridges on the road.

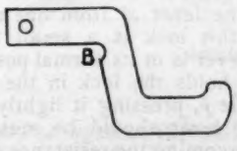
There are several stones in pavements in New York nearly approaching the size given above, notably the three which are in front of the stoops of Messrs. William H., Cornelius and William K. Vanderbilt, on Fifth Avenue.

This special car makes it possible to send these enormous stone platforms to almost any point that can be reached by rail.

The construction of the car, which can be readily understood from the engravings, is very ingenious, and reflects much credit upon its designer. It must be remembered that stones of the size mentioned above are not by any means easy to handle, and that as their cost increases very rapidly with their size, it is of much importance to prevent breakage and carry them safely, as well as to provide means for handling them.

HURST & TREANOR'S CAR FOR CARRYING LARGE STONES.

Fig. 3.



THE FIRST CHINESE RAILROAD.

THE Kaiping Railroad, which was first opened for traffic in November last, and which is the first railroad in China, is 86½ miles long, extending from the city of Tien-Tsin to Tong-Ku on the Peiho River, and thence to the coal-mines of the Chinese Mining & Engineering Company at Kaiping. A short section of seven miles of this road was built some years ago, from Tong-Ku to the Kaiping Canal, but was very little used, and the whole road is substantially new. It is intended chiefly to carry coal from the mines to the port of Tien-Tsin, but has already developed, it is stated, a considerable merchandise and passenger traffic, although it does not touch any large cities.

The line has been constructed by an English engineer, who has, however, applied much of American practice. The cars are of the eight-wheeled pattern common in this country, built after the American method, and are supplied with Janney couplers. A considerable number of chilled cast-iron wheels have also been used, and there will be a fair opportunity of testing their merits, as they will have to run in practical opposition to wrought-iron wheels with steel tires made in England. The passenger cars are 55 ft. long, and are mounted on two four-wheeled trucks of American pattern, with 42-in. Krupp wheels. The trucks are of iron and steel, the wood-work being entirely confined to the car body.

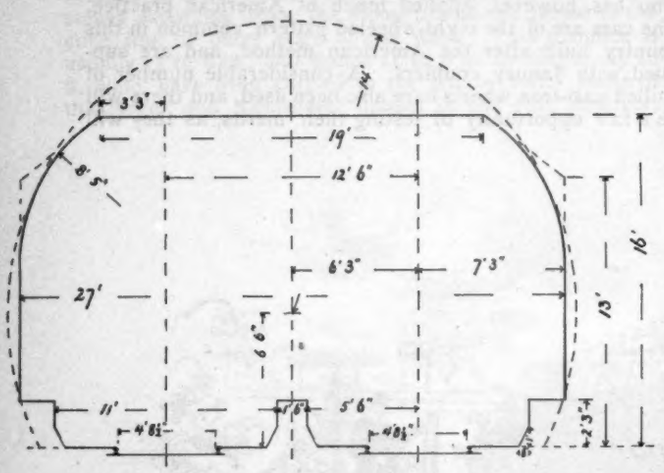
The road has been solidly built, with iron bridges and other work of a substantial character. The rails are of steel, 70 lbs. to the yard, with the ordinary fish-plate, it having been considered best to provide for a future increase of traffic rather than to lay a lighter rail now. A few steel ties were used in the substructure, but the most of the ties are of chestnut brought from Japan, where they are more cheaply obtained than in China. The ballast is of broken stone.

The accompanying sketch is an outline showing the minimum size of structure adopted for the road—that is, the space required for the passage of trains, to which tunnels, bridges, and other structures must conform.

The locomotives so far used, although built in England, follow American design, most of them being of the Mogul pattern; an engraving of one of these locomotives was given in the JOURNAL for January, 1888, page 28. American practice has been followed not only in general design, but in the use of steel fire-boxes and tubes, the only important deviation being in the use of the plate frame instead of our bar frame.

It is said that, although the road-bed is in very good condition, slight accidents have been at first quite numerous, chiefly owing to the carelessness or lack of knowledge of the switchmen, flagmen, and other employés, who are nearly all natives, and probably not yet fully educated to their work.

The estimate of traffic for the first year is: 180,000 passengers, 200,000 tons of coal, 40,000 tons of salt, and



30,000 tons of general freight. It has been thought expedient and necessary to fix rates at a low figure, but it is hoped that the road can be operated for about 50 per cent. of its gross earnings, and that in time it will return a profit on its cost in addition to the advantages it offers as an outlet for the coal-mines.

Three classes of passengers are provided for, after the European fashion, the first-class being provided with a car fitted like an ordinary American day coach; the second-class carried in a plainly furnished car, having a double row of seats running lengthwise, while the third-class passengers have to be seated on rough board seats in an ordinary box car. At present only mixed trains are run, and the speed does not exceed 20 miles an hour; but when business is more developed the company expects to run passenger trains at a higher speed.

This road was built under authority from the Viceroy, Li-Hung Chang. Subscriptions were asked for the stock from Chinese merchants generally, but, probably from distrust in this form of investment, they did not come forward, and the money for building the road was provided by the Viceroy and his subordinates, who subscribed a considerable amount, and by the coal company.

With regard to its effect on future construction of railroads in China, it may be said that the road is not so situated as to form any part of a general system of railroads for the country; but, on the other hand, it is conveniently placed for inspection by the great officials and others, who have their headquarters at Peking. There does not appear to be any official opposition to it at present. There has been some talk of an extension or branch to Peking, but this does not appear probable for some time to come.

AN IMPROVED STEAM PILE-DRIVER.

(From *Industries*.)

DIRECT-ACTING steam pile-drivers have now come into very general use for all works where time is an important element. The pile-driver illustrated herewith is an improvement on steam pile-drivers hitherto in ordinary use, in which the piston-rod and "monkey" are in one, and which of necessity have a stuffing-box at the bottom of the cylinder. In the machine shown the cylinder and monkey are in one casting, and form the movable part giving the blow to the pile, while the piston-rod remains stationary in relation to the pile. The bottom of the monkey being solid, there is no dripping of water from condensed steam on to the pile head. Another advantage in the De Wit pile-driver is that the steam hose or pipe which conveys steam from the boiler to the pile-driver remains stationary during working, consequently there is but little wear and tear. In the pile-driver under notice the piston-rod is fixed to an H iron frame, provided at its lower part with a foot, which rests upon and guides the head of the pile. A recess is cast in the monkey, as shown, to give room for this foot. As the pile descends, the frame, piston-rod, and piston descend with it. Steam is admitted into the cylinder or monkey through the hollow piston-rod and transverse holes immediately above the piston. Both piston and rod are in one forging. The admission and exhaust of steam is controlled by a three-way cock, worked by hand from a rope attached to a handle. The handle could be worked automatically, but this is not considered desirable. The machine is single acting, the cylinder and monkey being lifted by steam pressure, and falling free when the exhaust is opened. The pile-driver, controlled by hand, is capable of making from 30 to 33 strokes per minute, and of driving from 20 to 25 piles per day, according to the nature of the ground. Various sizes are made, the smallest having a monkey of 6 cwt., and the largest one of 30 cwt., the latter being the machine shown in our illustrations. The stroke of this machine is 6 ft. 5 in., and the diameter of cylinder 9½ in. The machine is constructed to drive piles up to 39 ft. 4 in. long. The frame-work is of timber, mounted upon four wheels. The boiler is of the vertical type, 10 ft. 6 in. high by 4 ft. 3 in. diameter, and the steam winch is supplied with two distinct motions, one for lifting the pile into position, and the other for raising the monkey. The total weight of the pile-driver is 7¼ tons, and there are 175 cubic feet of timber in the staging. We are informed that these pile-drivers have done good work at Antwerp, Bremen, and Amsterdam. They have also been used on the North-eastern Railway, and are being employed in the construction of the Manchester Ship Canal.

RAILROAD SIGNALS IN EUROPE.

(From the *Revue Generale des Chemins de Fer*.)

(*Continued from page 24.*)

V.—THE HEYDRICH SYSTEM.

THE object of the inventor of this system of interlocking is to reduce to a minimum the number of movements necessary to bring into play the interlocking, using the same lever which works the signals and the switches. With this purpose, M. Heydrich, while using a spring the action of which locks the lever as soon as it is touched, has modified this arrangement in the manner described below.

If we take a lever, *A*, fig. 38, in its normal position (the type is the same for the signals and for the switches), *B* being the sector which guides the movement of this lever, when we reverse it in order to bring it to the position marked A^1, against the working lever is a rod, *t*, which works the lock *V*, which falls into a slot made in the sector, and which must be drawn out of this slot when we wish to change the lever *A* from one of its positions to another; below this lock is a small S-shaped spring, which, when the lever is in its normal position, bears upon a button, *r*, and holds the lock in the slot. If we take hold of the handle *p*, pressing it lightly in the direction toward which the lever should be moved, the rod *t* is thrown down, overcoming the resistance of the spring, and throws the lock out of the slot. At the end of the throw of the lever the spring acts upon the lock in order to throw it up into the other slot. By this arrangement, under which the axis of rotation of the rod *t* and of the

lock *V* do not coincide with that of the lever *A*, M. Heydrich avoids the use of the oscillating lever, which is in the Saxby apparatus used to obtain the movement of the slotted interlocking levers.

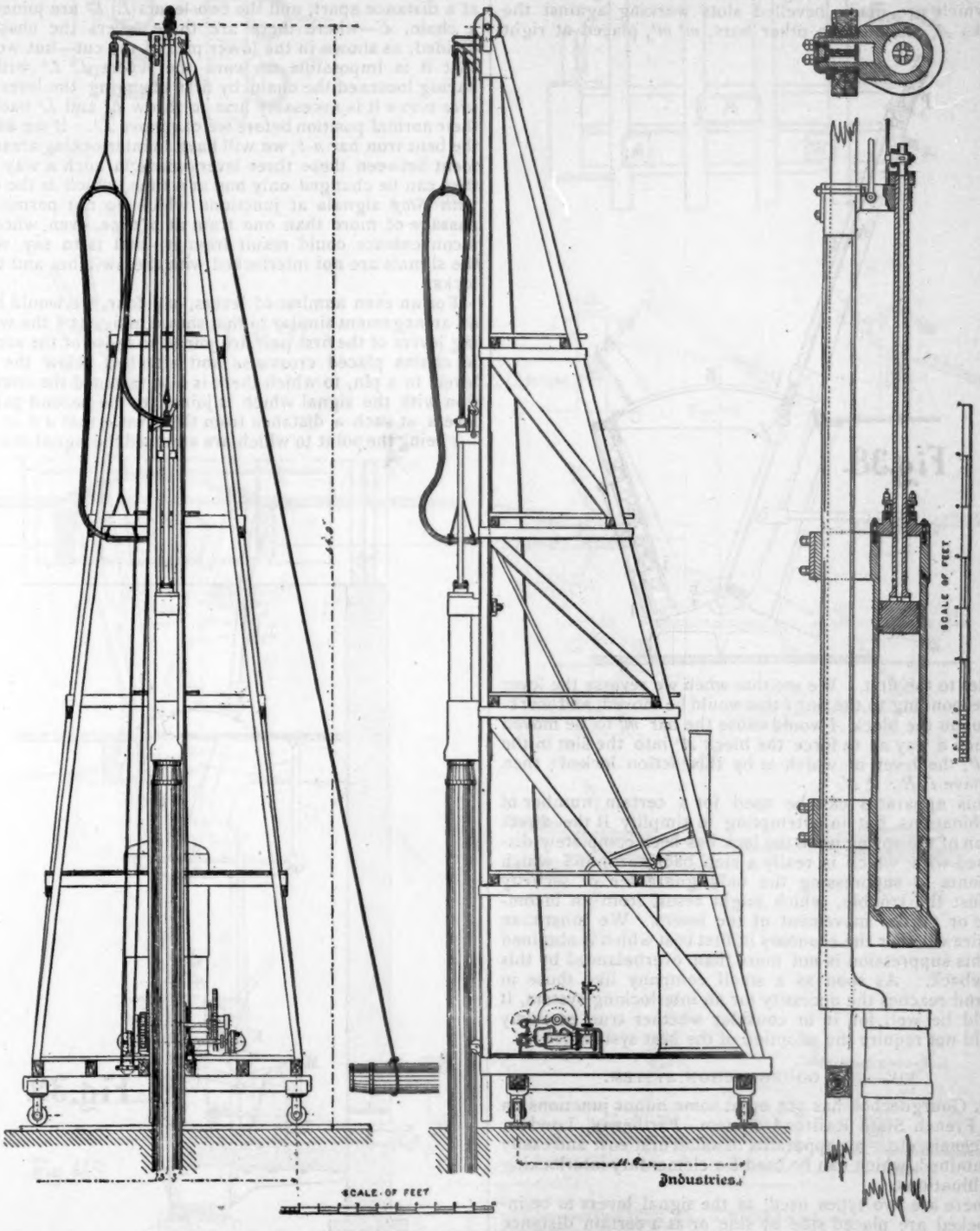
The command of the apparatus of the interlocking table is here given directly by the rod *t* through a lever *b*, the free end of which works the two rods *i* and *j*; the interlocking arms are fixed to the rod *i*, while to the rod *j* are attached horizontal tubes into slots in which these interlocking arms enter, or against the sides of which they bear.

As shown by fig. 40, the interlocking is produced by the rotation of these tubes around their axes, presenting to the interlocking arms either a groove or a plain side, according to their positions.

This apparatus has not a very extended place; it is used generally for small signal cabins, placed in docks and freight-houses; it would not be available for important signal posts in which compound interlocking systems are necessary.

VI.—THE RAILWAY SIGNAL COMPANY'S SYSTEM.

At the Liverpool Exhibition in 1886 there was an interlocking system exhibited by the Railway Signal Company and applied on the Lancashire & Yorkshire Railroad in England, and the Midland Great Western in Ireland. This company has attempted to secure a simplification of apparatus already in use, and has applied for that purpose an arrangement which recalls the Remery-Gautier system, which we have already described (page 20, January num-



IMPROVED STEAM PILE DRIVER.

ber of the JOURNAL), with this difference, that the interlocking arrangement instead of being above is under the floor of the signal cabin.

If we take a lever, *L*, fig. 41, with a spring catch, *p*, working around the axis *O*, and connecting it with the rod *t*, through which a signal or a switch is moved, at the point *i* there is fixed a horizontal bar, *b*, which moves in slides mounted on the interlocking table *T*. Fig. 42 shows in detail the arrangement of these bars, b^1 b^2 b^3 b^4, in which are made bevelled slots working against the blocks *A*, mounted on other bars, m^1 m^2, placed at right

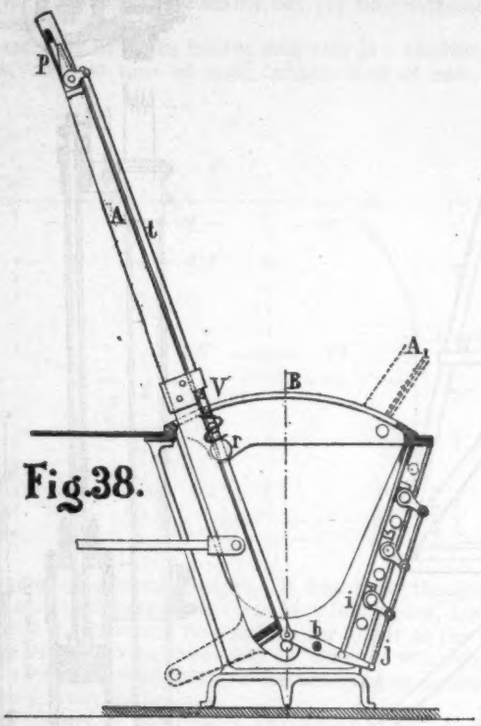


Fig.38.

angles to the first. We see that when we reverse the lever corresponding to the bar *i* this would be moved, and working upon the block *A* would cause the bar m^2 to be moved in such a way as to force the block A^2 into the slot in the bar i^4, the lever of which is by this action locked; then we have $i^1 R : i^4 N$.

This apparatus can be used for a certain number of combinations, but in attempting to simplify it the direct action of the spring upon the lock has been completely dispensed with, which is really a step backward, and which amounts to suppressing the only guarantee of security against the trouble, which might result from an incomplete or partial movement of the levers. We must then inquire whether the economy in first cost which is obtained by this suppression is not more than overbalanced by this drawback. As soon as a small company like those in Ireland reaches the necessity for an interlocking system, it would be well for it to consider whether true economy would not require the adoption of the best system.

VII.—THE GOURGUECHON SYSTEM.

M. Gourguechon has put up at some minor junctions on the French State Railroad System—Parthenay, Loudun, Marcenais, etc.—an apparatus of small first cost and easily maintained, which can be used for elementary interlocking combinations.

There are two types used, as the signal levers to be interlocked are placed side by side or at a certain distance apart.

A case where the two levers are placed side by side is shown in fig. 43, in which L^1 L^2 are the two levers to be locked, placed on either side of the stand *M*, on top of which a bent iron bar, *a b*, is pivoted to the axis *O*. When one of the two levers—L^2 for example—is worked, it strikes against the arm *a*, the bar turns, and the other arm, *b*, is thrown against the opposite lever in such a manner that it cannot be moved.

It may be remarked that the rotation of the bar *a b* only begins when the lever has already passed over nearly half of its course; both levers could then be raised to this halfway position, and cause, under certain conditions of tension of the connecting wires, the simultaneous movement of the two signals which it is intended to lock together. We are, therefore, it will be seen, far from the perfection which can be attained by the use of spring catches.

In fig. 44 we have a case where the signals are placed at a distance apart, and the two levers L^1 L^3 are joined by a chain, *C*—where there are three levers the chain is divided, as shown in the lower part of the cut—but we see that it is impossible to work the levers L^2 L^3 without having loosened the chain by first changing the lever L^1; *vice versa* it is necessary first to throw L^2 and L^3 back to their normal position before we can move L^1. If we adjust the bent iron bar *a b*, we will have an interlocking arrangement between these three levers made in such a way that they can be changed only one at a time, which is the case with *Stop* signals at junctions which do not permit the passage of more than one train at a time, even when no inconvenience could result from it—that is to say, when the signals are not interlocked with the switches and their locks.

For an even number of levers, say four, we would have an arrangement similar to that shown in fig. 45; the working levers of the first pair are joined to those of the second by chains placed crosswise and attached below the first levers to a pin, to which there is also fastened the connection with the signal which is joined to the second pair of levers, at such a distance from the pivot *a* that $a\,b = a\,c$, —*c* being the point to which are attached the signal connec-

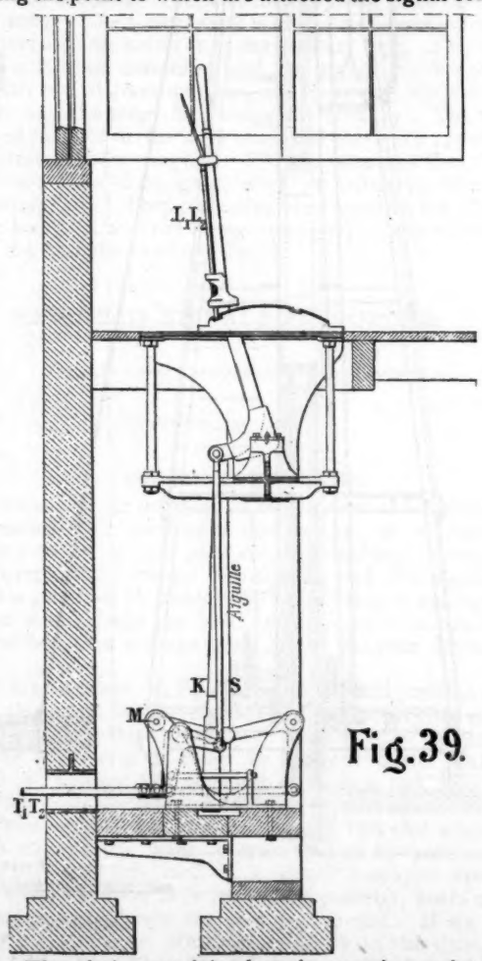


Fig.39.

tions. The chains are joined at the crossing point by an iron button, *i*. Their length is obtained in place by working successively the two levers of the same pair; in the two cases they should be stretched tight.

By combining the principal of this arrangement with the use of differential pulleys, M. Gourguechon obtains, as shown in fig. 46, interlocking relations somewhat more

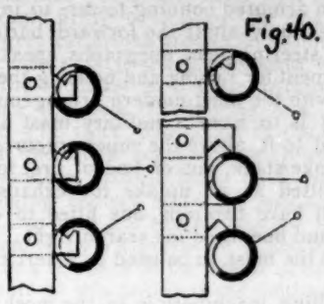


Fig. 40.

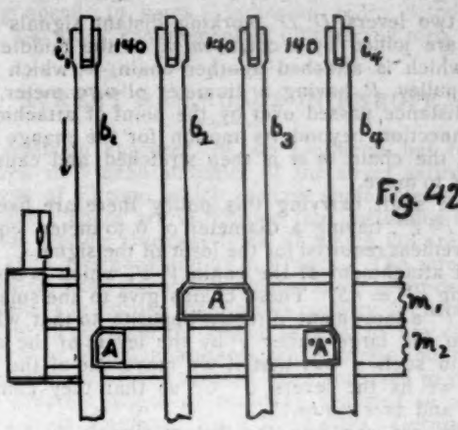


Fig. 42

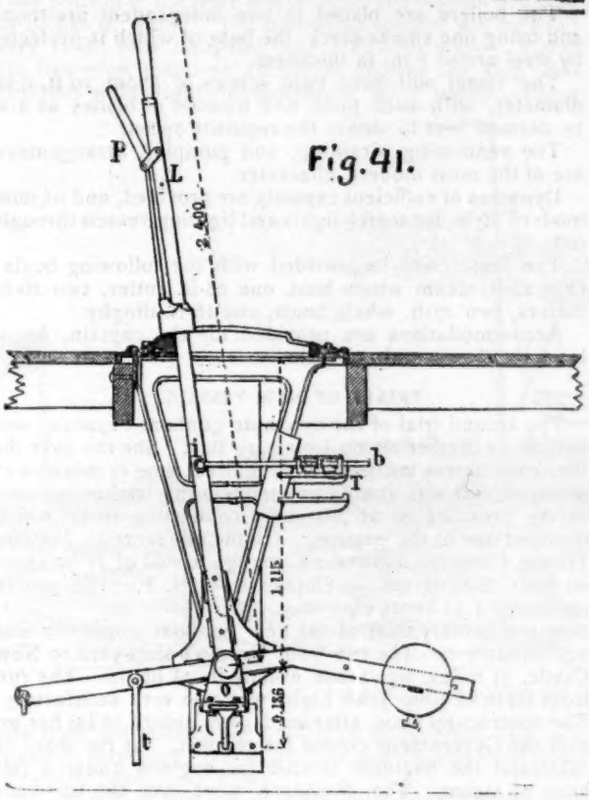


Fig. 41.

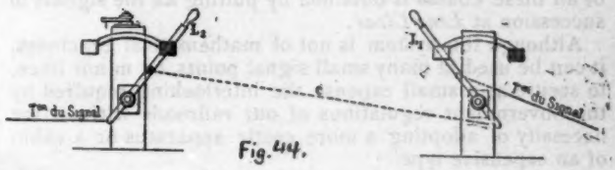
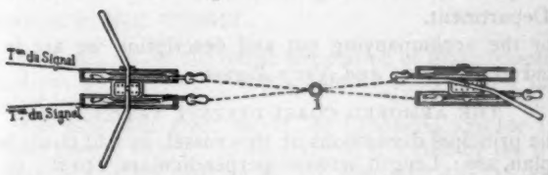


Fig. 44.

Fig. 45.



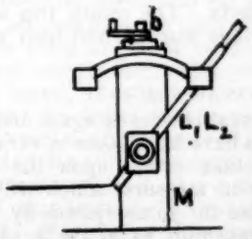


Fig. 43.

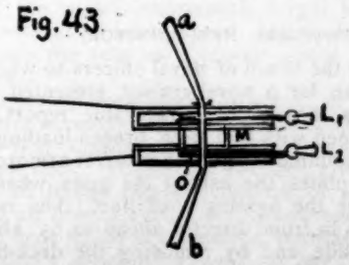
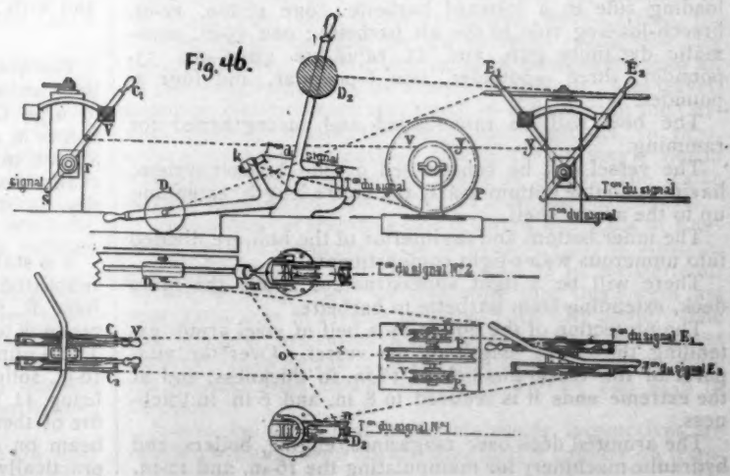


Fig. 46.



complex between junction signals, for instance, and station signals.

The two levers D^1 D^2 working distant signals of the station are joined by a chain, m m, at the middle point, O, at which is attached another chain, x, which works over a pulley, P, having a diameter of 0.70 meter, equal to the distance passed over by the point of attachment of the connection beyond its motion for the change of the signal; the chain m m is then stretched, and causes the pulley p to move.

To the shaft carrying this pulley there are fixed two others, P^1 P^2, having a diameter of 0.30 meter, equal to the movement required for the lever of the signal C^1 at the point of attachment of the chain V V, which is obtained by taking $rV = rS$. These chains give to the small pulleys P^1 P^2 a movement directly opposite to that which is given to the large pulley P by the levers of the distant signal, in such a way that if we move one of the levers D^1 D^2 we fix the levers C^1 C^2 so that they cannot be moved, and *vice versa*.

Finally, we can join the distant signals E^1 E^2 at the junction to the interlocking system by connecting their levers with small pulleys by other chains, y y. The length of all these chains is obtained by putting all the signals in succession at *Line Clear*.

Although this system is not of mathematical exactness, it can be used at many small signal points, on minor lines, to secure at a small expense the interlocking required by the Government regulations of our railroads without the necessity of adopting a more costly apparatus or a cabin of an expensive type.

In fact, it works well at several places where it has been in use, and this is an argument which is not without weight, while that of economy is a very important one for those minor or secondary lines which are just now increasing largely in number.

(TO BE CONTINUED.)

UNITED STATES NAVAL PROGRESS.

THE most interesting naval event of the past month has been the publication of the plans of the floating battery or coast-defense ship, the construction of which was authorized by Congress over a year ago. It is understood that the general design of this vessel originated with Secretary Whitney, the plans having been worked out in detail in the Department.

For the accompanying cut and description we are indebted to the *Army and Navy Register*.

THE ARMORED COAST-DEFENSE VESSEL.

The principal dimensions of this vessel, as laid down in the plan, are: Length between perpendiculars, 250 ft.; extreme breadth, 59 ft.; mean draft, 14 ft. 6 in.; displacement, 4,000 tons; engines, 5,400 H.P.

The battery will consist of one 110-ton, 16-in. breech-loading rifle in a forward barbette; one 46-ton, 12-in. breech-loading rifle in the aft barbette; one 15-in. pneumatic dynamite gun, and 15 rapid-fire guns—six 33-pounder, three 9-pounder, two 6-pounder, and four 3-pounder.

The bow will be ram-shaped and strengthened for ramming.

The vessel will be constructed on the bracket system, having a double bottom nearly the entire length, extending up to the armor shelf.

The inner bottom and the interior of the hull are divided into numerous water-tight compartments.

There will be a light superstructure above the main deck, extending from barbette to barbette.

The protection of the hull is by a belt of steel armor extending the entire length of the vessel. Over the vital parts of the vessel this belt is 16 in. in thickness, and at the extreme ends it is reduced to 8 in. and 6 in. in thickness.

The armored deck over magazines, engine, boilers, and hydraulic machinery for manipulating the 16-in. and 12-in. guns is 3 in. in thickness, and at the forward and the after ends of the vessel it is 2 in. in thickness.

There is an armored conning tower, 10 in. in thickness, located immediately abaft the forward barbette, in which are fitted the steering gear, telegraphs, speaking tubes, etc. The arrangement for raising and housing the anchors is in accordance with the most modern arrangements.

The vessel is to have a military mast about 20 in. in diameter, and 50 ft. above the superstructure deck, placed abaft the smoke-stack, out of line of fire, for signal purposes, and fitted as an uptake for exhaust ventilation. The mast will have two tops, one fitted to carry two machine guns and one fitted for search light. A steel boom is attached to the mast, to be used as a derrick for working the boats.

The propelling machinery is of the most modern type, and is capable of developing and maintaining under forced draft at least 5,400 indicated H.P. for at least four hours under standard conditions in the smooth-water trial.

The boilers are placed in two independent fire-rooms and using one smoke-stack, the base of which is protected by steel armor 6 in. in thickness.

The vessel will have twin screws of about 10 ft. 6 in. diameter, with such pitch and number of blades as may be deemed best to obtain the requisite speed.

The ventilating, draining, and pumping arrangements are of the most modern character.

Dynamos of sufficient capacity are provided, and of most modern style, for search lights and lighting vessels throughout.

The vessel will be provided with the following boats: One 28-ft. steam whale boat, one 28-ft. cutter, two 26-ft. cutters, two 27-ft. whale boats, one 18-ft. dinghy.

Accommodations are provided for the captain, for at least 16 officers and 150 men.

TRIALS OF NEW VESSELS.

The second trial of the dynamite gunboat *Vesuvius* was had on December 28, on Delaware Bay. She ran over the two-knot course inside of the required time (5 minutes 57 seconds), but was unable to complete the trial on account of the breaking of an air-pump connecting lever, which disabled one of the engines. On the official trial, January 11, the *Vesuvius* showed an average speed of 21.65 knots an hour, the engines developing 4,295 H. P. The course measured 2.54 knots each way.

A preliminary trial of the new gunboat *Yorktown* was had January 2. The run from Cramp's ship-yard to New Castle, 35 miles, was made exactly in 2½ hours. The run from there to Ship John Light was also very satisfactory. The contractors soon afterward gave orders to let her go over the Government course for the test. At the word of command the engineer started his engines under a full head of steam. The *Yorktown* went over the two-knot course both ways at the rate of 16.8 knots per hour. The first run over the track, going with the tide, was made in 7 minutes 2 seconds; the return against the tide was made in 7 minutes 15¾ seconds. The return trip was made in good time. The engines worked well both with natural and with forced draft.

NAVAL RESERVE.

The question of a naval reserve is again attracting public attention, and steps have been taken in various quarters to urge Congress to take action upon the bill already before it, or some similar measure, which will provide for a naval militia and also for some system by which merchant vessels can be taken for naval use in case of necessity.

A PROPOSED NEW MONITOR.

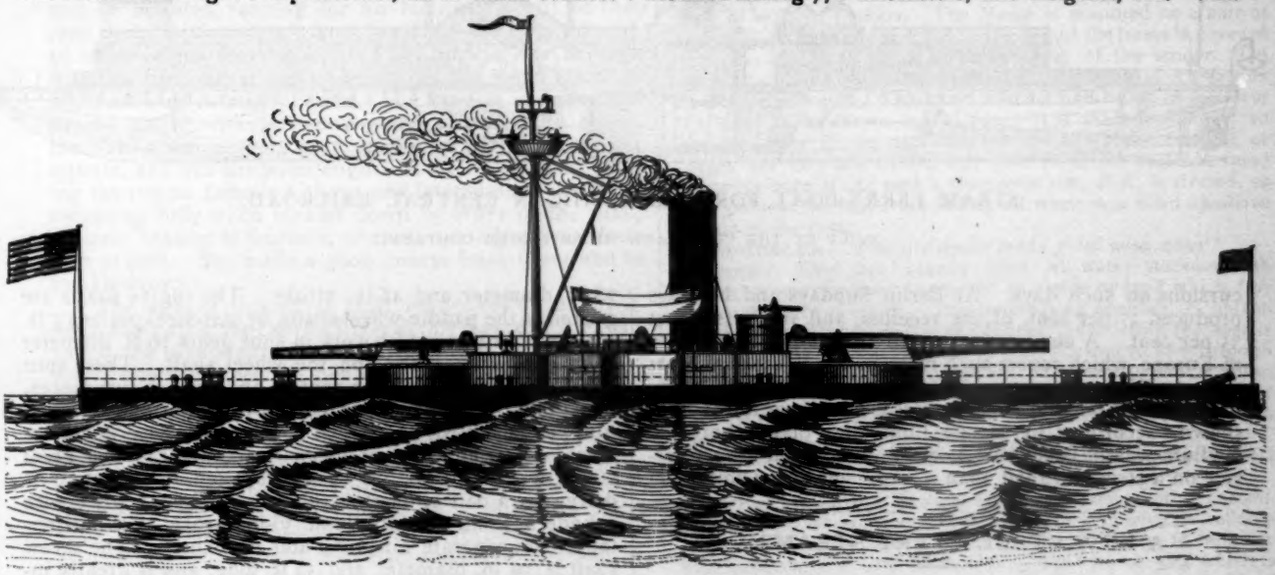
It is stated that the board of naval officers to which was submitted the plan for a novel cruiser, presented by Mr. John R. Thomas, has made a favorable report. This vessel is to be armed with two 10-in. breech-loading rifles. These guns are mounted forward in a turret armored with 10-in. solid steel plates, the axis of the guns, when level, being 11 ft. above the fighting load line. The range of fire of these guns is from directly ahead to 65° abaft the beam on either side, and by removing the deck-house a practically all-around fire is obtained. For closer quarters

she has a 15-in. dynamite gun of the Zalinski pattern, capable of throwing 800 pounds of high explosive compound. She has also two under-water bow torpedo tubes and one 6-in. rapid-firing breech-loading rifle located aft.

To give the greatest armor protection possible on a very limited displacement (3,130 tons), the armor has been disposed in the form of an arc of a circle, turning downward at the sides to 4 ft. below the fighting line. The armor on the crown is 3 in. thick, increasing at the sides to 5 in.

In order that the target presented to an enemy may be as small as possible, ballast tanks have been provided capable of holding enough water to lessen the cruising freeboard 3 ft., so that the target exposed in still water will be represented by a segment of a circle, rising from the water line to 4 ft. above at the center of the vessel.

A novel feature of this armor is the method of supporting it. This is done by a system of longitudinal and transverse girders 18 in. deep. On the inner side of these girders is worked a water-tight skin, serving—in the event of any portion of the deck armor being dislodged—to arrest any inrush of water. The transverse girders will be solid every 12 ft., thus localizing any inflow of water. Great care has been taken to subdivide further the ship into numerous water-tight compartments, all of which connect



THE NEW ARMORED COAST-DEFENSE VESSEL.

with both the circulating pumps of the engines and with powerful wrecking pumps, so that any compartment may be readily freed from water.

On the top of the armor deck have been erected tight false-works, increasing the cruising freeboard to 7 ft. 8 in. amidships and giving a comfortable working deck. In order that these false-works may not endanger the stability of the vessel in case they are riddled by machine-gun fire in action, the sides are built double, being 6 in. apart. The space between is filled with cellulose for the entire length of the vessel.

In order that the vessel may be used as a ram the bow is specially formed and strengthened for this purpose. She is also intended for manœuvring rapidly. Her large engine of 7,500 indicated H.P. acts on twin screws, giving a rate of speed of 17 knots. The rudder is moved by steam steering gear. Her radius of action is—for the displacement of the vessel—enormously large, being upward of 8,500 knots at 10 knots speed, her coal supply enabling her to keep the seas as a cruiser above 35 days without recoaling.

A temporary deck-house is a part of the false-works, giving airy accommodations for the officers during peace times. War accommodations have been provided below the armor deck. Great care has been given to the ventilation of all living spaces by means of powerful blowers drawing air from armored ducts, and natural ventilation, through deck lights and armored ventilators.

The ship's principal dimensions are: Length on load line, 235 ft.; beam, extreme, 55 ft.; draft, cruising, 14½ ft.; fighting, 17½ ft.; cruising displacement, 3,030 tons; cruising speed, 17 knots; indicated H.P., 7,500; coal supply, 550 tons; complement of officers and men, 119.

STREET RAILROADS IN EUROPE.

An Austrian engineer, M. de Lindheim, has recently published in Vienna statistics of the street railroads or tramways of Europe, which contain some interesting information. There are in Europe (not including Russia) 221 cities having tramway lines, of which 118 are in Europe; 43 in Germany and 23 in France. The street railroad system has evidently reached a much lower degree of development in Europe than in this country, for it is stated that there is no tramway known to exist in any city having less than 20,000 inhabitants, while in this country they are found in very much smaller cities and even in villages.

The greatest length of tramway reported in any one country is in England, 1,419 kilometers; Germany has only 843, and France, 770. Holland and Belgium are, in proportion to their roads, best supplied with these roads, Holland having 770 kilometers, and Belgium, 612. This is probably due to the dense population of those countries, and the proportionally large number of cities and towns which they contain.

The statistics given by M. de Lindheim are for 1887. The greatest number of passengers reported by the tramways of any one country of that year are 416,518,000 in England; the second being 245,658,000 in Germany. These figures seem small to us, and are very much below those of this country; in New York alone, for instance, in the same year 358,538,000 passengers were carried, including those traveling on the elevated roads, that city alone supplying more street railroad passengers than all of Germany and nearly as many as England. The travel, however, has increased very much in Europe. In the German cities of Berlin, Hamburg, and Stuttgart, in 1870, only 5,000,000 were carried, but in 1887 a single Berlin Company carried 94,000,000, while in Austria the traffic has increased from 12,000,000 to 83,000,000 passengers.

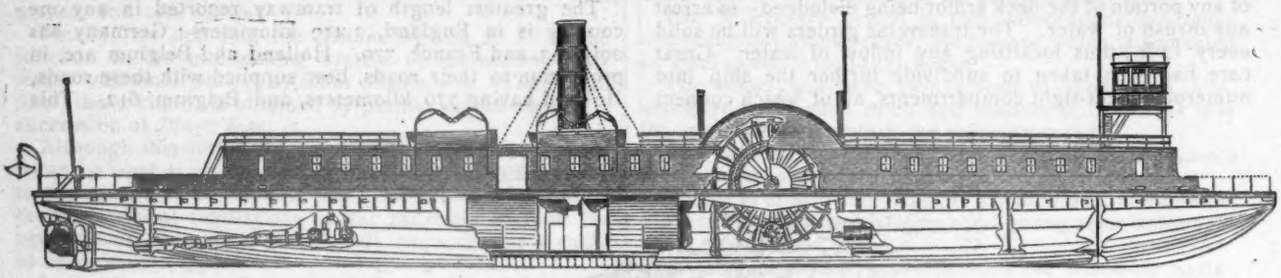
The number of tramway cars reported was 3,494 in England, 3,354 in Germany, 2,780 in France, 1,271 in Austria, 735 in Holland, 715 in Belgium, and 88 in Switzerland. By way of comparison, we may state that there were last year 3,054 cars in service in New York City alone. The cost of these cars varies in a remarkable way, the highest reported being $1,140 in Berlin and $917 in Breslau, while the amount runs down to $564 in Vienna and $556 in Cologne.

It is to be noted that steam motors or locomotives are much more employed abroad than in this country on tram-

ways, no less than 484 being in use on the English lines, 187 in Holland, 111 in Germany, 90 in Austria, 38 in France, and 34 in Belgium, and our authority reports that the use of mechanical motors is making constant progress. He is, himself, an active advocate of the electric motor, holding it to be far superior for tramway use, not only to horses but also to steam motors, and he claims that an electric car can be run for about two-thirds the cost of a horse car.

Some curious statistics are given as to the variation of the tramway traffic at different seasons of the year; thus at Berlin over 9 per cent. of the annual receipts, taking the average of a number of years, was taken in the month of May. July produced at Vienna about 12 per cent. of the annual receipts; at Brussels, 10 per cent. February showed the minimum almost everywhere, its general average being less than 5 per cent. In Vienna nearly 34 per cent. of the annual receipts were taken on Sundays and holidays, the Viennese being notoriously people extremely fond of excursions on such days. At Berlin Sundays and holidays produced 27 per cent. of the receipts, and in Paris about 35 per cent. A curious fact noted is that in all the cities of Europe which report such matters the lightest receipts were on Wednesdays.

It may also be noted that universal experience abroad has shown, according to M. de Lindheim, that a horse of medium weight is capable of much better and longer service on a street railroad than a large and heavy animal.



STEAM FERRY-BOAT FOR THE MICHIGAN CENTRAL RAILROAD.

BUILT BY THE CLEVELAND SHIP-BUILDING COMPANY.

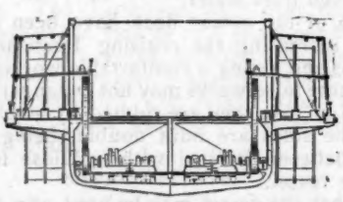
A NEW STEEL FERRY STEAMER.

THE Cleveland Ship-Building Company at Cleveland, O., recently completed a large steel ferry steamer to ply between Detroit, Mich., and Windsor, Ont., for the Michigan Central Railroad Company, on the ferry which completes the connection between the main line of that railroad and its Canada Southern Division. This boat, which is shown in the accompanying illustrations, is probably the heaviest steel vessel ever built on the Great Lakes, and both the owners and the builders feel confident that she will be able to transfer cars across the Detroit River in the severest weather, breaking through the heaviest ice that can form there, and keeping up the ferry without the annoying delays heretofore experienced in the winter.

This boat is 280 ft. long over all; 45 ft. 6 in. breadth of hull; 74 ft. 6 in. over the guards, and 17 ft. 3 in. deep. She is built entirely of steel, with the exception of the cabins for the crew; these are located on the guards, leaving a clear deck on which are laid three tracks, each long enough to accommodate seven of the largest cars. When light, but with an ordinary load of coal, etc., on board, the boat draws 9 ft. of water forward and 10 ft. aft; with 21 loaded cars on deck her draft will be about 11 ft. forward and 12 ft. aft. The pilot-house is located on a bridge placed 19 ft. above the main deck and near the bow.

The bow is of the most approved form for breaking through heavy ice, having a vertical section like a sled-runner, the regular scantlings of the ship being increased in weight and reinforced with extra keelsons and bulkheads to give it the necessary strength. The hull is covered with a steel deck; it has a collision bulkhead forward, and bulkheads between the store-room and engine-room; between engine-room and boiler-room; between boiler-room and after engine-room, and at the inboard end of the stern-pipe. The forward and after bulkheads are water-tight, which entirely relieves the vessel from the danger of sinking by contact with heavy ice, and all the bulkheads contribute to the strength of the hull. Between the bulkheads belt-frames are placed on every sixth frame, except for 60 ft. in the wake of the paddle-wheels, where they are placed on every other frame, experience having proved that unusual strength is necessary for boats in this place.

This vessel is propelled by paddle-wheels located forward of the center of its length on each side; these wheels are 27 ft. 6 in. in diameter with wooden arms and buckets all heavily cased in steel, the aggregate weight of each wheel being 66 tons. There is also a 9 ft. 6 in. propeller-wheel in the stern, especially designed for breaking ice. Each side-wheel is driven by a pair of high-pressure engines, geared at right angles to each other, with cylinders 28 in. diameter and 48-in. stroke. The engine shafts are geared to the paddle-wheel shafts by cast-steel pinions 5 ft. 4 in. in diameter, which work in spur gears 16 ft. diameter and 5⅛ in. pitch, placed on the wheel shaft. These spur gears are built of cast-iron centers and arms in two pieces, and 12 cast-steel segments composing the rim; all carefully bolted, fitted, and keyed together. These gears are machine-cut, and as now finished give assurance of great strength and durability. The propeller in the stern is driven by a pair of engines placed at right angles, with cylinders 28 in. diameter and 36-in. stroke, laid horizontally, with separate air-pump and condenser. The screw shaft is 10 in. diameter and 52 ft. long, and is greatly inclined, as the propeller wheel projects 12 in. below the hull proper, being protected by a solid forged skag, which carries the bottom pintle of a solid forged rudder. To protect the rudder when backing into heavy ice there is a



CROSS-SECTION OF STEAMER.

heavy forging framed into the hull, immediately above the rudder, extending down to its top line. This forging is covered by the outside plating of the hull, and when backing into heavy ice the rudder is put amidship, and a heavy bolt inserted through the forging into the rudder frame from the deck, thereby holding the rudder rigidly in a fore-and-aft direction. The after end of this forging extends down over the after corner of the rudder to prevent ice being driven between rudder and horn.

In the forward engine-room is located a beam engine with steam cylinder 16 in. diameter and 36-in. stroke, driving two air-pumps and four bilge-pumps. The center column of this beam engine forms a jet condenser, common to both side-wheel engines.

About the center of the vessel are located four marine,

return-flue boilers of the rectangular fire-box pattern, 11 ft. 6 in. diameter, 16 ft. long, and carrying a working pressure of 90 lbs. The aggregate grate surface is 252 square feet, and the heating surface 9,828 square feet. Along the center line of the ship, between the boilers, are two steam drums connected to a steam separator. The smoke connections are carried to the side of the hull, where they terminate in smoke-stacks, one on each side. Coal bunkers are located amidships, between boilers, extending full length of boiler-room.

Every room and compartment of hull and paddle houses is supplied with coils of pipe for steam heating. On account of the great difficulty of getting water when working in ice, this vessel is provided with 10 sea-cocks, located in different parts of the ship. In the engine-room is a Reynolds patent heater 42 in. diameter and 10 ft. high; also three pairs of duplex steam-pumps for fire purposes, feeding boilers, washing decks, pumping bilges, etc.

The following letter, dated Detroit, January 15, describes the voyage of this steamer from the yard at Cleveland, across the Lake to Detroit:

"The steel ferry steamer *Transfer* arrived here at 2.15 P.M., January 13, and tied up to the Michigan Central Dock, having made the run from Cleveland in 11 hours and 12 minutes, running for an hour and a half of that time under a slow check, and breaking her way through 50 miles of ice from 4 in. to 6 in. thick. Her average speed in open water was 12 miles per hour, and about 10 miles an hour through the ice. She handles perfectly and steams easily with all her engines at maximum speed. Her side-wheel engines were started at 52 revolutions per minute, and her propeller engine at 85 revolutions, making the trip to Detroit without any interruption whatever, excepting only when slowed down by order of the pilot, without heating of journals, alteration or adjustment from port to port. She made a good course from Cleveland to the Dummy.

"The sight of this novel craft, regardless of all precedent, navigating the Detroit River at this season of the year, called the inhabitants of the surrounding country to the river, who welcomed the steamer with waving of flags and handkerchiefs. Immediately upon arrival she was inspected by the boat experts of the city and pronounced a great improvement upon any boat previously built for ferrying on the Detroit River. She was inspected early Monday morning by President Ledyard, General Superintendent Brown, and Assistant General Superintendent Miller of the Michigan Central Railroad, who expressed themselves as perfectly satisfied with the vessel and her appurtenances. On the voyage over the steamer was under command of Commodore Innes of the Michigan Central Ferry Line, assisted by Captain McLaughlin of the passenger steamer *City of Cleveland*. The machinery was in charge of Chief-Engineer Westaway. There were many guests on board, and the builders, the Cleveland Ship Building Company, were represented by H. D. Coffinberry, President; O. N. Steele, Superintendent of Machine Shops; T. W. Bristow, Superintendent of Ship Yards, and J. C. Wallace, Superintending Engineer.

"The weather was fine and nothing occurred during the voyage to mar the pleasure of the trip or give anxiety to those most interested."

Southern Manufactures.

THE *Chattanooga Tradesman*, in its first issue of the year, publishes a large table showing the number of new enterprises actually undertaken in the South during the past year, including factories of all sorts, agricultural implements, cotton and woollen factories, foundries and machine shops, etc. It may be noted that the new enterprises in the iron manufacture continued to increase during the year, 30 blast-furnace companies, 7 rolling-mill companies, and 145 machine-shop companies having been organized, while no less than 217 mining companies were formed, a very large proportion of these being iron-mining companies. There were 12 new car-works started and 3 bridge-works. The general development was indicated by the fact that during the year 253 new railroad companies and 87 street railroad companies were organized, besides 74 electric-light companies in different cities and towns.

CATECHISM OF THE LOCOMOTIVE.

(Revised and enlarged.)

By M. N. Forney.

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(*Continued from page* 39.)

CHAPTER XXII.

TENDERS.

QUESTION 589. *What are locomotive tenders for?*

Answer. They carry a supply of fuel and water for locomotives while they are running.

QUESTION 590. *How are they constructed?*

Answer. The construction of a locomotive tender is shown and is represented by figs. 356 to 360. Fig. 356 is a side view, fig. 357 a plan, fig. 358 a longitudinal section, fig. 359 an inverted plan, and fig. 360 a front view with the forward truck omitted. It has a rectangular frame, *A A A A*, made of either iron or wood. The frame shown in the engravings is made of iron channel bars, which are rolled bars whose section is similar in form to a letter *E*. Tender frames are, however, often made of wooden timbers. The frame is mounted on a pair of trucks, *B B*, figs. 356 and 358. The top of the frame is covered with planks, *C C C*, which form the floor of the tender. On top of this floor a sheet-iron tank, *D D*, is placed, which carries the supply of water. This tank is made somewhat in the form of a letter ⊃, as shown in the plan. It is made in this way so that the space *B'*, fig. 357, between the two branches *D D*, or "legs," as they are called, will give room for fuel. Around the upper edge of the tank a sheet-iron rim, *E E*, is riveted, so as to prevent the fuel from falling off when it is filled up above the top of the tank.

QUESTION 591. *How are tender tanks filled with water?*

Answer. They are usually filled at water stations with leather or canvas hose connected to a pipe or tank which furnishes a supply of water. The tank has an opening, *F*, on top called a "man-hole" or "filling funnel" into which the hose is inserted, and a stream of water is then allowed to flow through the hose into the tank of the tender. The tank which supplies water to the tender is located higher than the tender, and the water is usually pumped into this tank so that it will run into the tender.

QUESTION 592. *What other way is there of filling tenders with water?*

Answer. To avoid frequent stops for water, express passenger locomotives are sometimes provided with what is called a "water-scoop" for taking water while the engine is running. This consists of a bent tube, *G G G*, figs. 356 to 360, which is attached to the under side of the tank and extends up inside of it to the top. A long trough, *H H H*, figs. 358 and 360, is then laid between the rails and filled with water. The lower end of the bent tube or scoop has a joint or hinge at *I*, so that it can be lowered into the trough, so that the lower end *J* of the scoop will dip a few inches into the water. The motion of the engine then scoops up the water, which is forced up the tube *G G* and discharged into the tank at *K*, fig. 358.

QUESTION 593. *How is the end of the scoop lowered into the water?*

Answer. A shaft, *L*, with two arms, *M* and *N*, is located above the lower end of the scoop. One of these arms, *N*, is connected by a link, *O*, to the movable part of the scoop, and the other arm, *M*, is connected by a rod, *M P* (shown by dotted lines in fig. 358), to a lever, *P Q R*. The fulcrum of this lever is at *Q*, and it has a handle, *R*, at the top. By moving the upper end of the lever backward the scoop is lowered, and by moving it forward the scoop is raised.

QUESTION 594. *How is the water conducted from the tender to the engine?*

Answer. To each side of the front end of the tank one end of a piece of rubber hose *S*, is attached, which is connected at the other end to the pipe on the engine which supplies the pump with water. In some cases this hose is connected directly to the tender tank, but in others small cast-iron cisterns, *T T*, are attached to the bottom of the tank, and the hose is connected to them. The purpose of these cisterns is to prevent air being drawn into the hose when the tank is nearly empty, which would interfere with the working of the pumps or injectors.

QUESTION 595. *How is communication opened and closed between the hose and the tank so as to "turn on" and "shut off" water from the hose?*

Answer. This is done by valves, *U U*, in the bottom of the

Fig. 356.

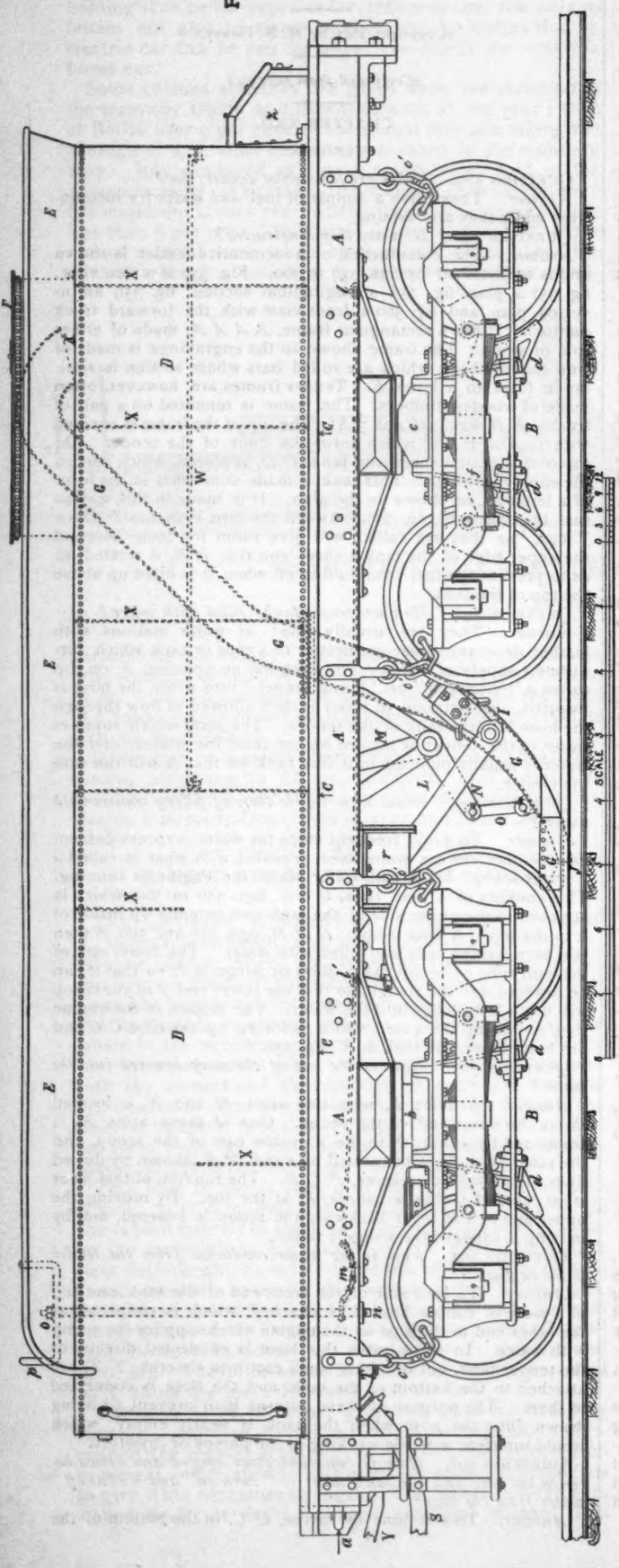
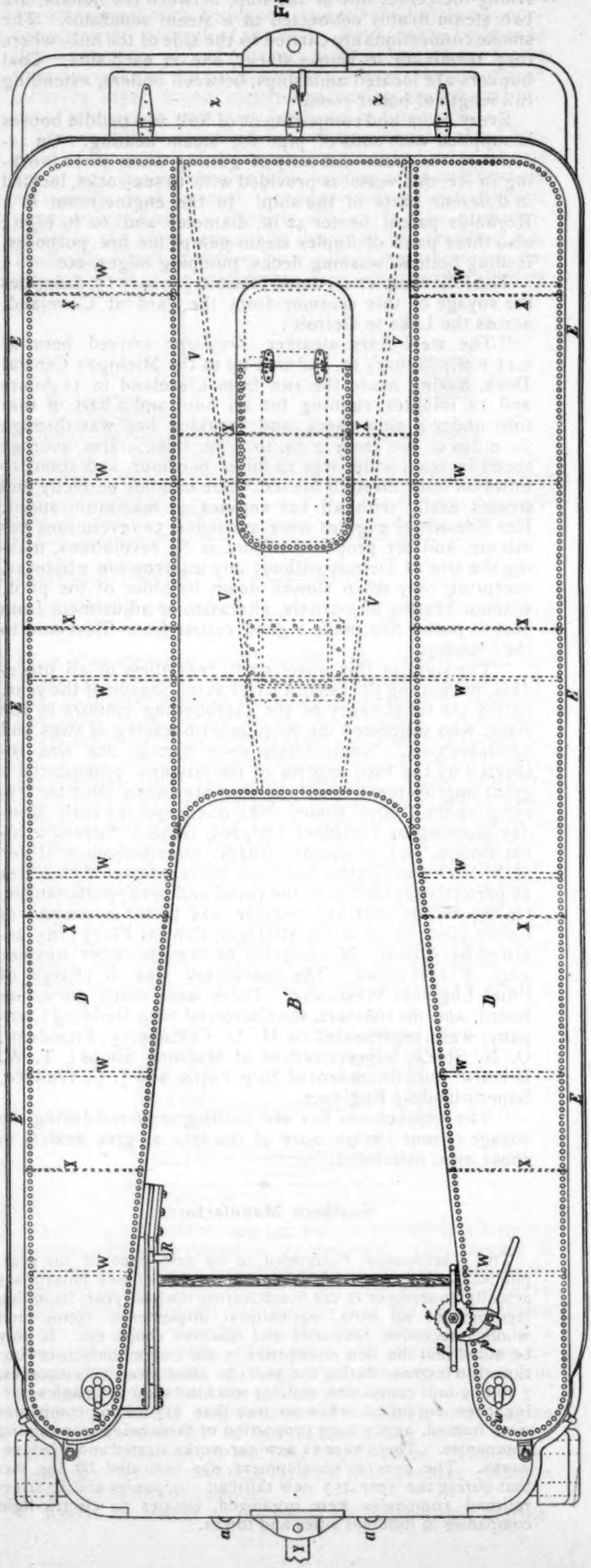


Fig. 357.



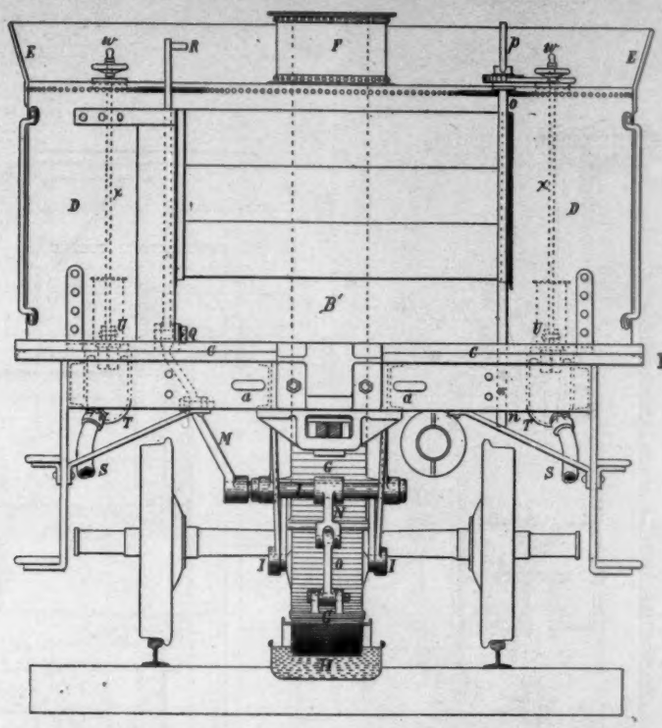


Fig. 360.

tank. A section of one of these valves, with the appliances for opening and closing it, and the cistern, already referred to, is shown on an enlarged scale by figs. 361, 362 and 363. *C* is the cistern and *V* the valve, which is operated by means of a rod, *R R*. This rod has a screw on its upper end, which is screwed into a casting, *A*, that is riveted to the top of the tank. The

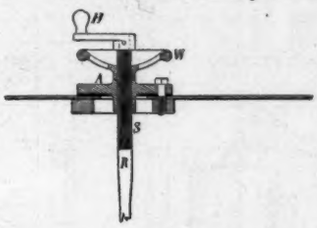


Fig. 361.

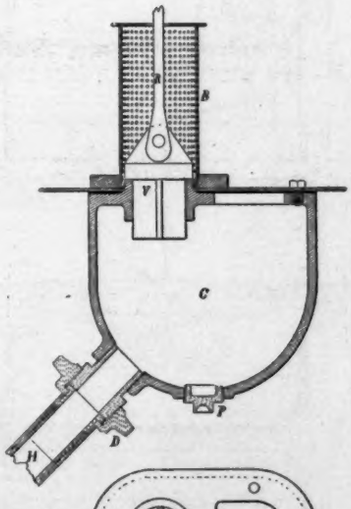


Fig. 362.

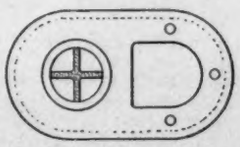


Fig. 363.

screw is turned by a crank and handle, *H*, on its upper end. When it is turned in one direction the valve is raised, and if turned the opposite way it is lowered. The wheel *W* is also screwed on the rod *R*, and acts as a check or lock nut to hold the rod and valve in any desired position. The valve is covered with a hood or strainer, *B*, perforated with small holes, which is intended to prevent dirt from entering the hose and thus getting into and obstructing the pump or injector. The hose is connected to the cistern and to the supply pipe by a screw-coupling, *D*, similar to that used with ordinary fire-engine hose.

QUESTION 596. *How are the flat sides of the tank strengthened so as to resist the pressure and weight of the water?*

Answer. They are sometimes braced or stayed with rods or bars, *V V* and *W W*, figs. 356, 357, and 358, extending from one side to the other and from the top to the bottom, and angle or T iron is also riveted to the sides to stiffen them.

QUESTION 597. *How is the violent motion or swash of the water in the tank prevented?*

Answer. Transverse plates, *X X X*, called "swash-plates," are placed in the tank to resist the movement of the water when the tender stops or starts suddenly.

QUESTION 598. *How is the tender connected to the engine?*

Answer. By the draw-bar *Y* and coupling-pin *Z*, fig. 358, and also by the safety chains 50, Plate IV, which are connected to the eyes *a a*, figs. 359 and 360.

QUESTION 599. *In what respect do the tender trucks differ from the engine truck?*

Answer. Chiefly in having the journal-bearings and frames outside of the wheels.

QUESTION 600. *Why are the bearings placed outside instead of between the wheels?*

Answer. Because if they are outside they are then more accessible than if they are between the wheels, and the oil-boxes on the axles can be entirely closed over the ends of the axles, so that no oil can leak out, whereas if the boxes are inside, they must be left open at both ends. When the boxes are on the outside, they can be oiled, or a journal-bearing can be removed and a new one put in its place, with much less difficulty than if the boxes were on the inside of the wheels. The only reason why the bearings of engine-truck-axles are placed inside the wheels is because they would be in the way of the cylinders if they were outside.

QUESTION 601. *How are the axle-boxes for the tender axle constructed?*

Answer. Their construction is similar to that of a car axle-box, the standard form of which is represented in figs. 364, 365, and 366. Fig. 364 is a section lengthwise of the axle, fig. 365 a sectional plan, and fig. 366 a section crosswise of the axle. *A* is the journal of the axle, which is enclosed by a cast-iron box, *K K*, which is open in front and at the back. The front has a cover, *H*, which is either fastened by a spring, as shown in the illustrations, or is bolted to the box. The axle enters the box from the back, *I*, and has either a wood or leather packing, *J J*, called a *dust-guard*, to keep the dust from getting in and the oil from leaking out of the box. *D* is a brass journal-bearing which rests against a cast-iron bearing piece or *key*, *E*, which is put in so that by removing it through the opening *F*, the brass bearing can be raised up high enough to clear the col-

Fig. 358.

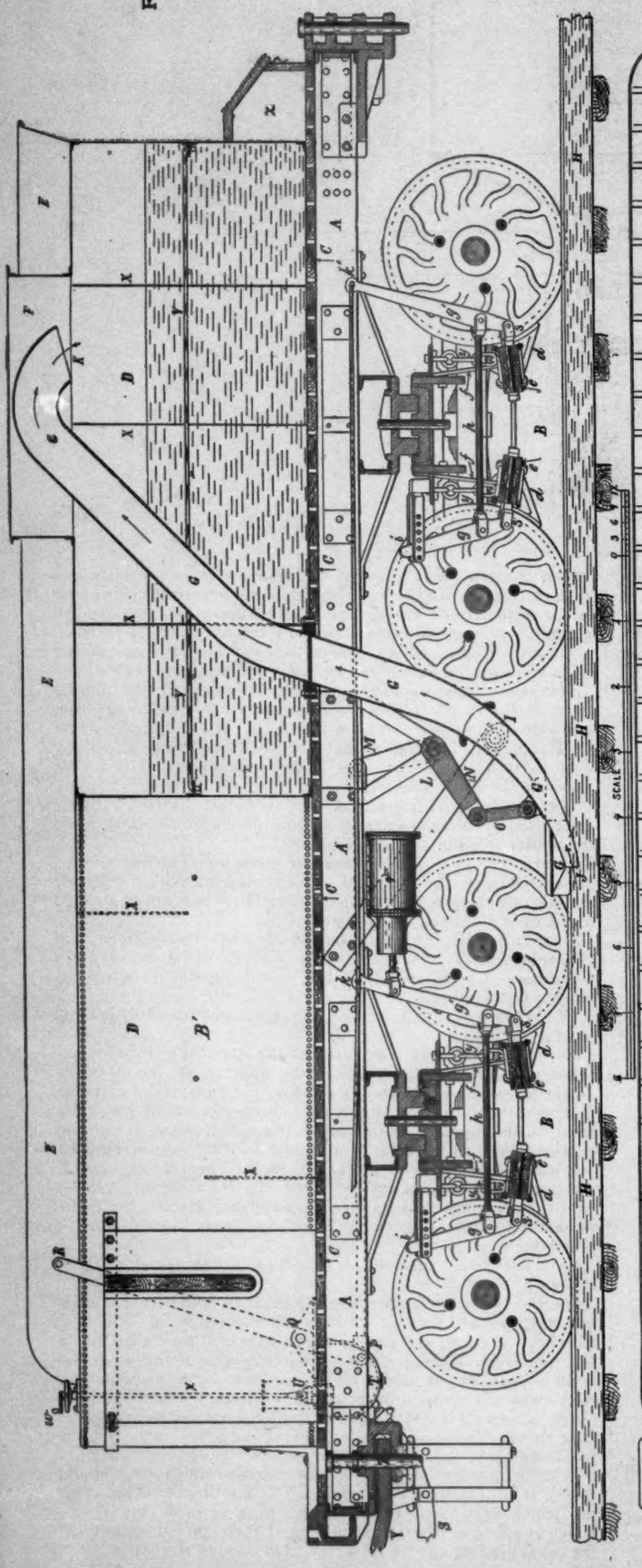
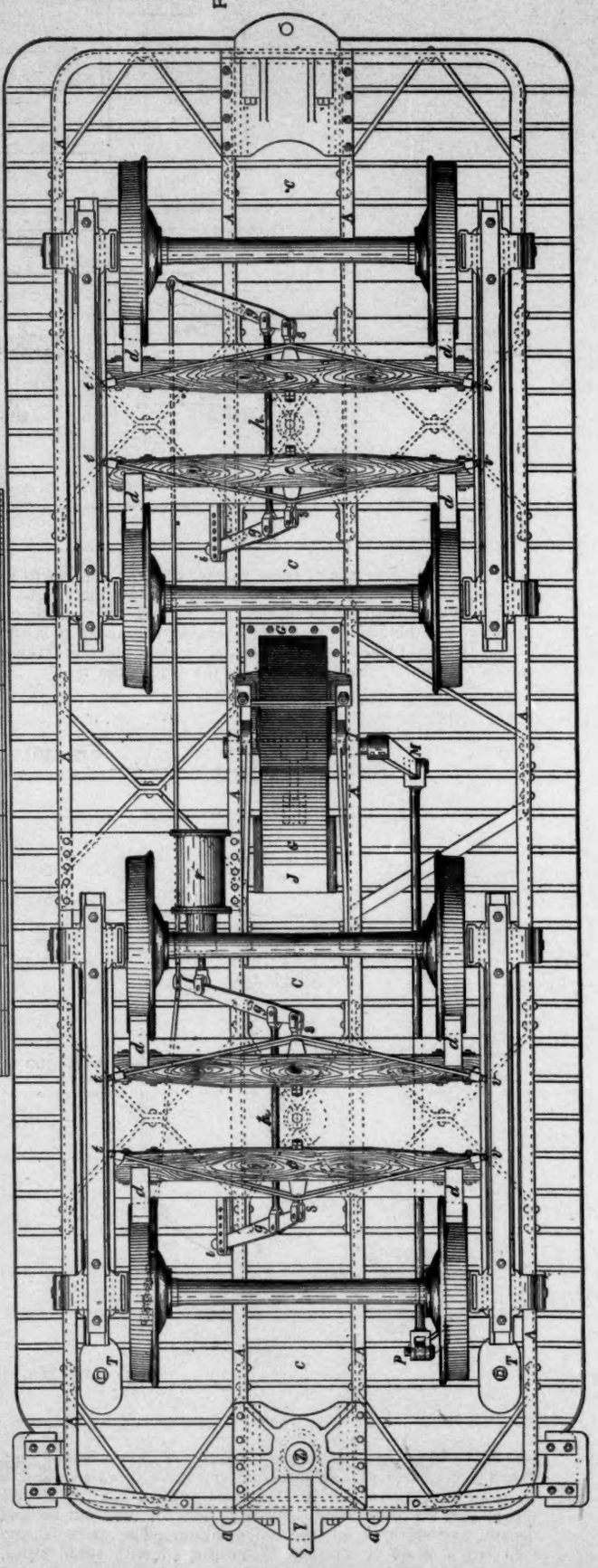


Fig. 359.



lar *G* on the end of the axle and thus be removed in the same way. The lower portion, *L*, of the box under the axle is usually filled with cotton or woolen waste saturated with oil. This constantly presses against the axle, and thus keeps it oiled.

QUESTION 602. *How are the tender trucks constructed?*

Answer. They are made of various patterns, some of which have wooden frames, but they are now usually made of iron. The truck illustrated in figs. 356, 358, and 359 is made of iron, and is very similar to the four-wheeled engine truck which has been illustrated, excepting, as pointed out, that the frames and

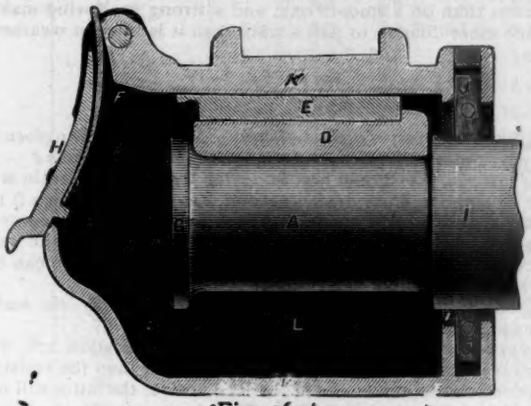


Fig. 364.

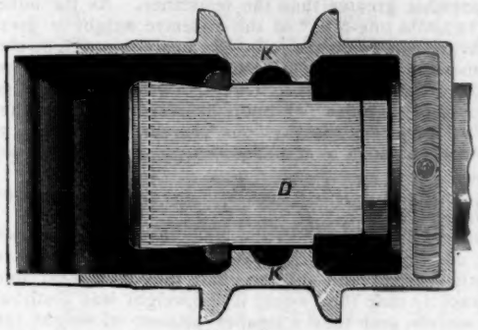


Fig. 365.

journal-bearings are outside the wheels instead of between them.

QUESTION 603. *How are the tenders supported on the trucks?*

Answer. Usually they rest on the center-plate *b*, fig. 358, of the front truck and on bearings *c* on the frames on each side of the back truck. This arrangement gives three bearing points, the advantages of which have already been explained. A truck which supports the load which it carries in the center is said to be *center-bearing*, and if the load is carried on each side, *side-bearing*.

QUESTION 604 *How are the brakes applied to the tender?*

Answer. They are often applied to one truck alone, but both trucks should always have brakes attached to them.

QUESTION 605. *What are the chains c' c' c' c', fig. 356, for?*

Answer. These chains are fastened by one end to the corners of the truck frames and to the tender frame by the other, so as to hold the trucks parallel with the track in case they should get off the rails, as explained in answer to Question 502.

QUESTION 606. *What are the brakes for and how are they constructed?*

Answer. The brakes are for the purpose of stopping the locomotive and tender quickly. They consist of cast-iron blocks, *d d*, figs. 356, 358, and 359, called brake-blocks or brake-shoes, which are attached to transverse wooden or iron beams, *e e*, called *brake-beams*. These beams are suspended from the truck frame by links or hangers, *f f*, called "*brake-hangers*." Levers *g g g g*, called "*brake-levers*," are attached to the middle of these beams by pivoted fulcrums. The two levers on each truck are connected together by rods *h* and *h*. The upper end of one of each pair of these levers is held fast by a pin at *i*, and the upper ends *k k* of the other lever are connected together by a rod, *l l*, fig. 356; *l'* is connected by a rod and chain *m* to a shaft, *n o*. The chain is wound in the shaft, which is turned by a crank, *p*, on the upper end. By this means the upper ends *k k'* of the levers are drawn toward the shaft, which forces the brake blocks against the wheels. A piston in the cylinder *r* is also connected with one of the brake-levers. The piston is operated by compressed air, the action of which will be fully explained in the chapter on air brakes.

CHAPTER XXIII.

THE RESISTANCE OF TRAINS.*

QUESTION 607. *What is meant by the resistance of trains or cars?*

Answer. It is the power required to move them on the track. Thus if a rope, fig. 367, was attached to a car at one end, and

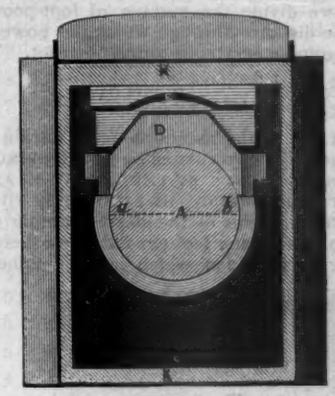


Fig. 366.

the other passed over a pulley, *a*, and a sufficiently heavy weight, *W*, was hung on the end of the rope, it would move the car. The weight *W* would then be equal to the resistance of the car.

QUESTION 608. *How can the resistance of cars under different circumstances be determined?*

Answer. It has been found that it takes a force of about 6 lbs. per ton (of 2,000 lbs.) to move a car slowly on a level and straight track after it is started. That is, if a car weighs 20 tons and a rope, fig. 219, is attached to it at one end and the other passed over a pulley, *a*, with a weight, *W*, suspended to it, it will require a weight equal to $20 \times 6 = 120$ lbs. to keep the car moving slowly. If two cars of the above weight were coupled together, it would require twice 120, or 240 lbs., and if three were attached to each other, three times 120, or 360 lbs., and so on. In other words, MULTIPLYING THE TOTAL WEIGHT OF THE CARS IN TONS (OF 2,000 LBS.) BY 6 WILL GIVE US THEIR RESISTANCE, OR THE FORCE REQUIRED TO KEEP THEM MOVING ON A LEVEL AND STRAIGHT TRACK AT A SLOW SPEED AFTER THEY ARE STARTED. The resistance is represented by the weight above, and the locomotive must exert a force equal to that weight to keep the train moving. As the speed increases the resistance increases, as is shown by the following table. It should be stated here, however, that our knowledge regarding this whole subject of the resistance of American cars and trains is exceedingly inaccurate and imperfect, and the data given in the books are largely based on experiments made in Europe, with cars of a different construction from those used here. There is reason for believing, however, that the resistance of American cars is less than that of European cars, and we have assumed it to be 6 lbs. per ton on a level at very slow speed, which is less than the resistance which is usually given; but the following figures should be regarded merely as an approximation to the actual facts, of which we are still in ignorance:

Velocity of trains in miles per hour.....	5	10	15	20	25	30	35	40	45	50	60	70
Resistance on straight line in lbs. per ton (of 2,000 lbs.).....	6.1	6.6	7.3	8.3	9.6	11.2	13.1	15.3	17.8	20.6	27	34.6

Now, if we want to get the resistance at 30 miles an hour of a train of 10 cars weighing each 20 tons, the calculation would be $10 \times 20 \times 11\frac{1}{4} = 2{,}250$ lbs. This will give the resistance on a level and straight track. On an ascending grade the resistance is greater than that given above, because, besides pulling the car horizontally, it is necessary to raise it vertically a distance equal to the ascent of the grade. Thus if we have a grade with a rise of forty feet in a mile, the amount of energy required to simply raise the weight of a car would be equal to its weight in pounds multiplied by the vertical height of the

* Since 1873, when the above chapter was written, a considerable number of experiments have been made on the resistance of cars and trains, and much has been written on the subject, but not much additional light has been thrown on it. The original data relating to this subject are therefore retained, although the resistances given are probably too high rather than too low.

ascent. Thus, supposing a car which weighs 40,000 lbs. to be run one mile on a grade of 40 feet ascent in that distance, then the energy expended in simply raising the car will be equal to 40,000 × 40 = 1,600,000 foot-pounds. Now, if it was necessary to raise that weight by a direct vertical lift or pull, it would require a force equal to or a little greater than the load to do it. But in pulling a car or train up a grade, which is an inclined plane, the force, which is the locomotive, instead of being exerted through the vertical distance is exerted through the horizontal distance, which in this case is one mile, or 5,280 feet. Therefore, if we divide the number of foot-pounds of energy required by the distance through which the power is exerted, it will give us the force exerted through one foot. That is,

$$\frac{1,600,000}{5,280} = 303.03 \text{ lbs.}$$

The resistance due to the ascent alone of a train on a grade or incline can therefore be calculated by MULTIPLYING THE WEIGHT OF THE TRAIN IN POUNDS BY THE ASCENT IN ANY GIVEN DISTANCE IN FEET AND DIVIDING THE PRODUCT BY THE HORIZONTAL DISTANCE IN FEET. Thus in the above example the rate of the ascent is given in so many feet per mile ; we therefore multiply by 40 and divide by 5,280, which is the number of feet in a

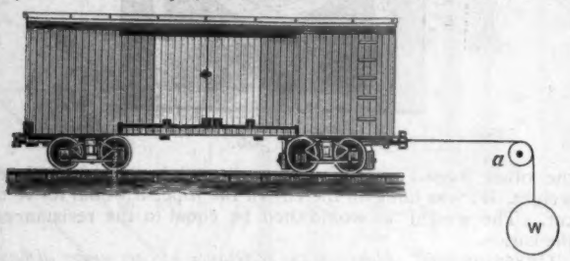


Fig. 367.

mile. If the rate of the gradient had been given, as it sometimes is, as 1 in 132, we would simply have divided the weight of the train by the latter number. If we want to get the resistance per ton of train we substitute for its weight that of one ton in pounds ; thus :

$$\frac{2,000 \times 40}{5,280} = 15.1 \text{ lbs.}$$

If, now, we have the resistance which is due to the *ascent or gravity alone*, we must add to this the resistance on a straight and level track, at the speed at which the train runs, in order to determine the total resistance on the grade. On a level road at a speed of 5 miles per hour it would be 6.1 lbs. per ton, so that on a grade of 40 feet to a mile at that speed the resistance would be 6.1 + 15.1 = 21.2 lbs., per ton, and at 10 miles it would be 6.6 + 15.1 = 21.7 lbs., and at 30 miles per hour on the grade the resistance would be 11.2 + 15.1 = 26.3 lbs. per ton. To get the total resistance on a grade for any speed, we ADD THE RESISTANCE FOR THAT SPEED ON A STRAIGHT AND LEVEL LINE TO THE RESISTANCE DUE TO THE ASCENT ALONE. The resistances for various rates of speed and grades has been calculated, and is given in the table herewith.

The top horizontal row of figures of the table gives the rates of speed. The left-hand vertical row gives the rise of grade in feet per mile. The resistance for any given grade and speed is given where the vertical row of figures under the rate of speed and the horizontal row opposite the rise of the grade intersect each other. Thus, for a grade of 30 feet per mile and a speed of 45 miles per hour, we follow the vertical column under the 45 downward, and the horizontal column opposite 30 to the right, and where the two intersect the resistance, 29.1 lbs., is given.

QUESTION 609. *What effect do curves have on the resistance of trains?*

Answer. They increase the resistance, but in what proportion or to what extent is not known accurately. European authorities say that the resistance is increased, over what it would be in a straight and level line, about 1 per cent. for every degree of the curve occupied by a train. It is probable, however, that the resistance of American cars, which nearly all have double trucks, is not so great on curves as that of European cars, which nearly all have long and rigid wheel-bases, and whose wheels therefore cannot adjust themselves so easily to the curvature of the track as they can when the American system of double trucks is used.

QUESTION 610. *What is meant by a degree of a curve?*

Answer. In order to measure circles, they are all supposed to be divided into 360 equal parts, which are called degrees. One degree of a curve is therefore $\frac{1}{360}$ of a complete circle ; but if the curve has a long radius, one degree of such a curved track will be longer than one degree of a curve with a short radius, but each will have the same amount of "bend" or curvature. It is this latter which increases the resistance of trains, and the greater the number of degrees of a curve occupied by a train of cars, the greater will be the "bend" of the track, and therefore the greater the resistance.

QUESTION 611. *What other causes affect the resistance of trains?*

Answer. The condition of the track and the force and direction of the wind. On a rough track the resistance is very much greater than on a smooth one, and a strong head-wind makes it much more difficult to pull a train than it is in calm weather.

CHAPTER XXIV.

PROPORTIONS OF LOCOMOTIVES.

QUESTION 612. *In proportioning a locomotive to any given kind of work, what are the first facts which should be known?*

Answer. We should first know the weight of the train which the locomotive must draw ; second, the speed at which it must run ; and, third, the steepest grades and the shortest curves of the road on which it must work. From these data the resistance of the train which the locomotive must overcome can be at least approximately determined.

QUESTION 613. *When the greatest resistance of the train is known, what is the next thing to be determined?*

Answer. As was stated in answer to Question 276, if the wheels revolve and their adhesion is greater than the resistance opposed to the movement of the locomotive, the latter will overcome the resistance ; but if the latter is greater than the friction, the wheels will slip. It therefore follows that the adhesion must be somewhat greater than the resistance. As the adhesion is equal to about one-fifth * of the adhesive weight or pressure of the driving-wheels on the rails, obviously this weight should be five times the resistance. Thus, if we have a train weighing 400 tons which we want to take up a grade of 40 feet per mile at a speed of 20 miles per hour, its resistance, calculated from the table given in the previous chapter, would be 9,360 lbs. Therefore, 9,360 × 5 = 46,800 lbs. = the required adhesive weight.

QUESTION 614. *What considerations determine the manner of distributing this weight on the wheels?*

Answer. It is found by experience that if too much weight is placed upon one wheel, the material of which the rails are made is partly crushed and injured, and they then wear out much more rapidly than they would if the weight was distributed on more wheels, and thus a smaller amount of weight rested on each point of contact with the rails. The amount of weight which can be carried on a single wheel depends upon the material of which the rails are made, and to some extent on their form and size, or, as the latter is usually expressed, on their weight per yard.

QUESTION 615. *When the adhesive weight and the number of driving-wheels are known, how is the size of the latter determined?*

Answer. The size of the wheels will to a certain extent depend upon the speed, because the larger the wheels, the further will the locomotive move in one revolution ; but no exact rule can be given for their size. At present there is still a great diversity of opinion among engineers regarding the best sizes of wheels for any given service. Probably the safest plan will be to consult the best practice, and in the absence of any better reasons be guided by that.

QUESTION 616. *What requirement determines the size of the cylinders?*

Answer. The cylinders must be large enough so that with the maximum steam pressure in the boiler, they can always turn the driving-wheels when the locomotive is starting, but their size should not be much greater than is needed to turn the wheels, because if they are the pressure on the pistons is liable to cause the wheels to slip on the rails.

QUESTION 617. *How much force must be exerted to turn the driving-wheels?*

Answer. The maximum force which must be exerted to turn the wheels is that required to overcome their friction or adhesion to the rails and make them slip. The adhesion, as explained in Chapter XIV., varies from one-third to one-sixth of the weight bearing on the rails. The cylinders should, therefore, be so proportioned that the greatest tractive force which will be exerted by the pistons will be equal to this adhesion. As it is only under very favorable conditions that the adhesion of the driving-wheels is equal to a third of the weight on them, in calculating the size of cylinders the adhesion should be assumed to be one-fourth the weight on the wheels.

With an ordinary slide valve and link motion working in full

* See answer to question 403.

Table of Resistances of Railroad Trains with Different Grades and Speeds.

Rise of gradient, feet per mile.	Resistance due to ascent alone in lbs. per ton (2,000 lbs.) of train.	Total resistance, lbs. per ton, at rate of 5 miles per hour.	10 miles per hour.	15 miles per hour.	20 miles per hour.	25 miles per hour.	30 miles per hour.	35 miles per hour.	40 miles per hour.	45 miles per hour.	50 miles per hour.	60 miles per hour.	70 miles per hour.
0		6.1	6.6	7.3	8.3	9.6	11.2	13.1	15.3	17.8	20.6	27.0	34.6
5	1.8	7.9	8.4	9.1	10.1	11.4	13.0	14.9	17.1	19.6	22.4	28.8	36.4
10	3.7	9.8	10.3	11.0	12.0	13.4	14.9	16 8	19.0	21.5	24 3	30.7	38.3
15	5.6	11.7	12.2	12.9	13.9	15.2	16.8	18.7	21.9	24.4	27 2	33.6	41.2
20	7.5	13.6	14.1	14.8	15.8	17.1	18 7	20.6	22.8	25.3	28.1	34.5	42.1
25	9.4	15.5	16.0	16.7	17.7	19.0	20.6	22 5	24.7	27.2	31.0	37.4	45 0
30	11.3	17.4	17.9	18.6	19.6	21.9	22.5	24 4	26.6	29 1	31.9	38.3	45.9
35	13.2	19.3	19.8	20.5	21.5	22.8	24 4	26.3	28.5	31.0	33.8	40.2	47.8
40	15.1	21 2	21.7	22.4	23.4	24.7	26.3	28.2	30.4	32.9	35.7	42.1	49.7
45	17.0	23 1	23.6	24.3	25.3	26.6	28 2	30.1	32.3	34 8	37 6	44 0	51.6
50	18.9	25.0	25 5	26.2	27.2	28.5	30.1	32 0	34.2	36.7	39.5	45.9	53.5
60	22 7	28.8	29.3	30.0	31.0	32.3	33 9	35.8	38.0	40.5	43.5	49.9	57.5
70	26.5	32.6	33.1	33.8	34.8	36.1	37.7	39 6	41 8	44.3	47.1	53.5	61.1
80	30.3	36.4	36.9	37.6	38.6	39.9	40.5	42.4	44.6	47.1	49.9	56.3	63.9
90	34.0	41.0	40.6	41.3	42 3	43.6	45.2	47.1	49.3	51.8	54 6	61.0	68.6
100	37.8	43.9	44.4	45.1	46.1	47.4	49.0	51.9	54.1	56.6	59.4	65.8	73.4
110	41.6	47.7	48.2	48.9	49.9	51.2	52.8	54.7	56.9	59.4	62.2	68.6	76.2
120	45.4	51.5	52.0	52.7	53.7	55 0	56 6	58.5	60.7	63.2	66.0	72.4	80.0
130	49.2	55.3	55.8	56.5	57 5	58.8	60 4	62.3	64.5	67 0	69.8	76.2	83.8
140	53.0	59.1	59.6	60.3	61.3	62.6	64.2	66.1	68.3	70.8	73.6	80.0	87 6
150	56.8	62.9	63.4	64.1	65.1	66.4	68.0	69.9	72.1	74.6	77.4	83.8	91.4
160	60.6	66.7	67.2	67.9	68.9	70.2	71.8	73.7	75.9	78.4	81.2	87.6	95.2
170	64.3	70.4	70.9	71.6	72.6	73.9	75.5	77.4	79 6	82.1	84.9	91.3	98.9
180	68.1	74.2	74.7	75.4	76.4	77.7	79.3	81.2	83.4	85.9	88 7	95.1	102.7
190	71.9	78.0	78 5	79.2	80 2	81.5	83.1	85.0	87.2	89.7	92.5	98.9	106 5
200	75.7	81.8	82.3	83.0	84.0	85.3	86.9	88.8	91.0	93.5	96.3	102.7	110.3
210	79.5	85.6	86.1	86.8	87.8	89.1	90.7	92.6	94.8	97 3	100.1	106.5	114.1
220	83.3	89.4	89.9	90.6	91.6	92 9	94.5	96 4	98.6	101.1	103.9	110.3	117.6
230	87.1	93.2	93.7	94.4	95.4	96.7	98.3	100.2	102 4	104.9	107.7	114 1	121.7
240	90.8	96.9	97.4	98.1	99.1	100.4	102.0	103.9	106.1	108.6	111.4	117.8	125.4
250	94.6	100.7	101 2	101.9	102.9	103.2	105.8	107.7	109.9	112.4	115 2	121.6	129 2
260	98.4	104.5	105.0	105.7	106.7	107.0	108.6	110.5	112 7	115.2	118 0	124.4	132 0
270	102.2	108.3	108 8	109.5	110.5	111 8	113.4	115.3	117.5	120 0	122.8	129.2	136.8
280	106 0	112.1	112.6	113.3	114.3	115 6	117.2	119.1	121.3	123 8	126.6	133.0	140.6
290	109.8	115.9	116.4	117.1	118.1	119 4	121.0	122.9	125.1	127.6	130.4	136 8	144.4
300	113.6	119.7	120.2	120.9	121.9	123.2	124.8	126.7	128.9	131 4	134.2	140 6	148.2

gear, the greatest average pressure in the cylinders at a slow speed is about 90 per cent. of the boiler pressure. From this the greatest mean tractive force may be calculated by the rule given in answer to Question 405.* As the stroke of the pistons is usually known, the problem generally is to determine the diameter of the cylinders, which, with an average pressure of 90 per cent. of the maximum boiler pressure, will give a tractive force equal to the adhesion of the wheels, assuming that to be equal to the weight on them. Having the adhesion and knowing the boiler pressure, the tractive force for different-sized cylinders can be calculated until the diameter is found which will be of the right size. But as this will be tedious, the following rule, which will give the right diameter with one calculation, will be found convenient:

TO GET THE AREA OF THE PISTONS OF A LOCOMOTIVE.

MULTIPLY ONE-FOURTH OF THE WHOLE WEIGHT (IN POUNDS) WHICH RESTS ON THE RAILS UNDER THE DRIVING-WHEELS BY THE CIRCUMFERENCE (IN INCHES) OF THESE WHEELS. THEN MULTIPLY 90 PER CENT. OF THE MAXIMUM BOILER PRESSURE (IN LBS. PER SQUARE INCH) BY FOUR TIMES THE STROKE OF THE PISTON (IN INCHES), AND DIVIDE THE FIRST PRODUCT BY THE SECOND. THE QUOTIENT WILL BE THE AREA OF EACH PISTON IN SQUARE INCHES.*

To apply this rule to an actual example, an engine with pistons 18 in. diameter and 24-in. stroke, and with driving-wheels 5½ ft. = 66 in. in diameter, loaded with 64,000 lbs. = 32 tons and a maximum boiler pressure of 150 lbs. per square inch, will be taken. The circumference of these wheels will be 207.3 in., so that by the rule we will have:

* NOTE.—A committee of the Master Mechanics' Association appointed to report on this subject have recommended that the pressure in the cylinders be taken at 85 per cent. of the boiler pressure; but in order to have the cylinders as nearly of the right size as possible during all conditions of the tires, they based their calculations on the diameter of the tires when half worn out. As this introduces an element of confusion in comparing the dimensions of different engines, it has been preferred to base the calculations on a somewhat higher percentage of boiler pressure and on the original diameter of the tires, which gives nearly the same results and avoids the confusion referred to.

* NOTE.—This rule has been worked out algebraically as follows:
Let A = Area of one piston (in square inches).
P = Maximum boiler pressure (per square inch).
p = Mean pressure (per square inch) in the cylinder.
S = Stroke of piston (in inches).
C = Circumference of driving-wheels (in inches).
W = Total weight on rails below all the driving-wheels (in pounds).
As p is assumed to be = .90 P the tractive force, by the rule given in answer to Question 405, will be $= \frac{A \times .90\ P \times 4\ S}{C}$.

The adhesion has been assumed to be equal to ¼ W, and as the tractive force and the adhesion should be equal, we have

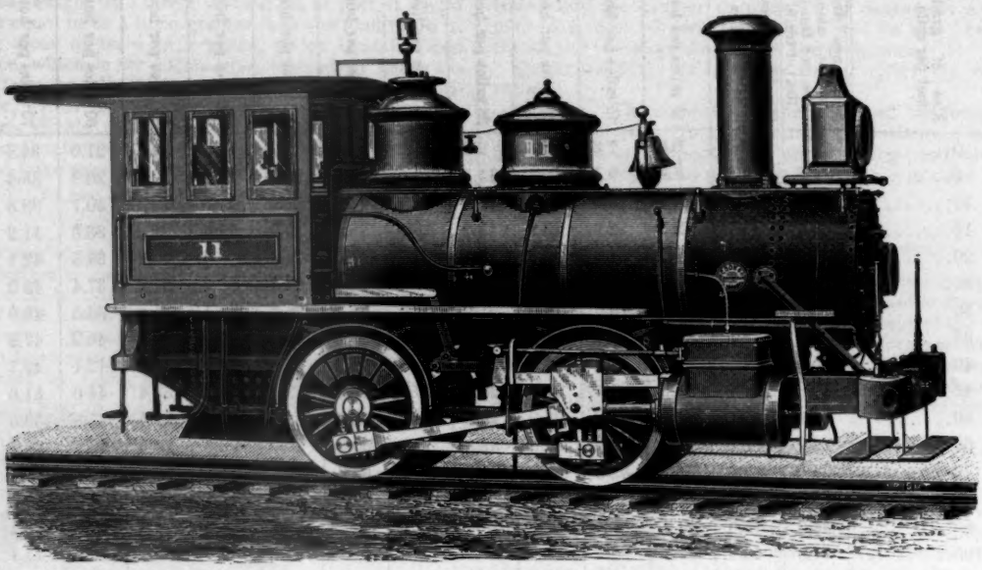
$$\frac{A \times .90\ P \times 4\ S}{C} = \tfrac{1}{4}\ W,$$

from which we have

$$A = \frac{\frac{1}{4}\ W \times C}{.90\ P \times 4\ S}.$$

It is not easy to give the demonstration of this rule without the use of algebra, and those not acquainted with that branch of mathematics must accept the rule on faith.

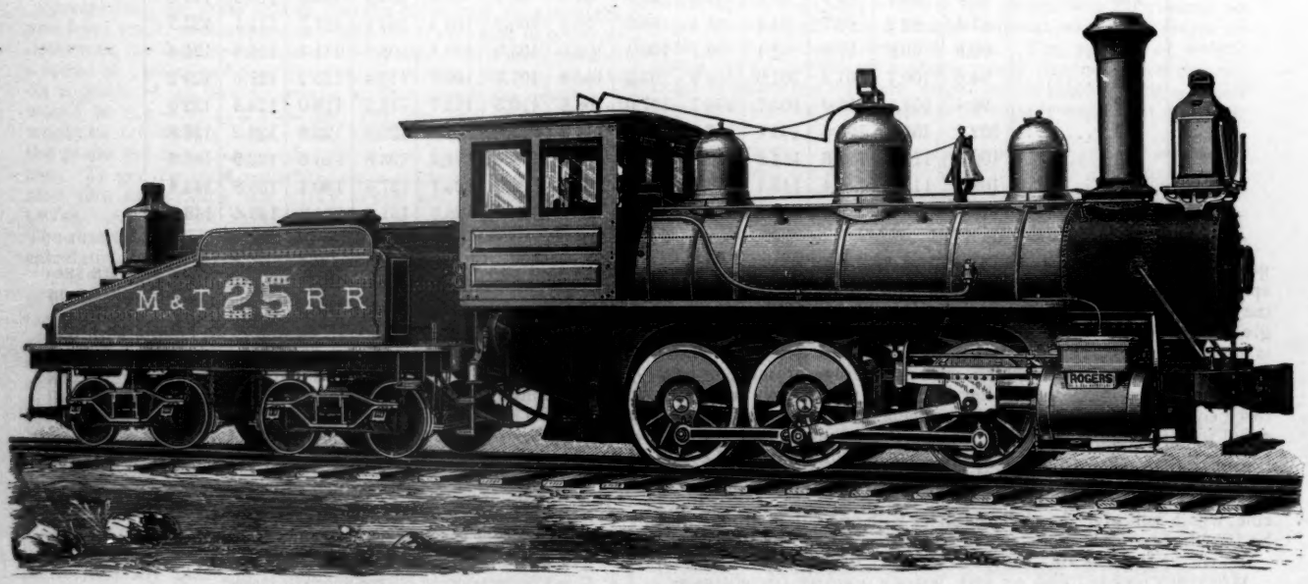
CATECHISM OF THE LOCOMOTIVE.



FOUR-WHEELED SWITCHING LOCOMOTIVE.

BY THE COOKE LOCOMOTIVE & MACHINE WORKS, PATERSON, N. J.

Total weight in working order	59,000 lbs.	Length of fire-box, inside	4 ft. 0 in.	Exhaust nozzles	Single.
Total weight on driving wheels	59,000 "	Width of fire-box, inside	2 " 10 "	Size of steam-ports	15½×1¼ in.
Diameter of driving wheels	4 ft. 0 in.	Depth of fire-box, crown-sheet to top of grate	4 " 3 "	Size of exhaust-ports	15½×2¼ "
Diameter of main driving-axle journal	7 "	Number of tubes	150	Throw of eccentrics	5½ "
Distance from center of front to center of back driving-wheel	6 ft. 10½ "	Outside diameter of tubes	2 in.	Greatest travel of valve	5 "
Total wheel-base of engine	6 " 10½ "	Length of tubes	10 ft. 5¾ "	Outside lap of valve	0¾ "
Total wheel-base of engine and tender	31 " 5½ "	Grate surface	11½ sq. ft.	Smallest inside diameter of chimney	1 ft. 4 "
Diameter of cylinders	16 "	Heating surface, fire-box	73 " "	Height, top of rail to top of chimney	12 " 9 "
Stroke of cylinders	24 "	Heating surface, tubes	711 " "	Height, top of rail to center of boiler	5 " 8½ "
Outside diameter of smallest boiler ring	48 "	Heating surface, total	784 " "	Water capacity of tank	2,000 gals.



SIX-WHEELED SWITCHING LOCOMOTIVE.

BY THE ROGERS LOCOMOTIVE & MACHINE WORKS, PATERSON, N. J.

Total weight in working order	85,000 lbs.	Length of fire-box, inside	4 ft. 6 in.	Exhaust nozzles	Double.
Total weight on driving wheels	85,000 "	Width of fire-box, inside	2 " 9¾ "	Size of steam-ports	14½×1¼ in.
Diameter of driving wheels	4 ft. 2 in.	Depth of fire-box, crown-sheet to top of grate	5 " 0 "	Size of exhaust-ports	14½×2½ "
Diameter of main driving-axle journal	7 "	Number of tubes	123	Throw of eccentrics	5 "
Distance from center of front to center of back driving-wheel	10 ft. 6 "	Outside diameter of tubes	2¼ in.	Greatest travel of valve	5 "
Total wheel-base of engine	10 " 6 "	Length of tubes	13 ft. 10½ "	Outside lap of valve	0 11/16 "
Total wheel-base of engine and tender	37 " 1 "	Grate surface	12⅔ sq. ft.	Smallest inside diameter of chimney	1 ft. 3 "
Diameter of cylinders	17 "	Heating surface, fire-box	83 " "	Height, top of rail to top of chimney	14 " 6 "
Stroke of cylinders	24 "	Heating surface, tubes	1,005 " "	Height, top of rail to center of boiler	6 " 3¾ "
Outside diameter of smallest boiler ring	51 "	Heating surface, total	1,088 " "	Diameter of tender-truck wheels	2 " 9 "
				Water capacity of tank	2,000 gals.

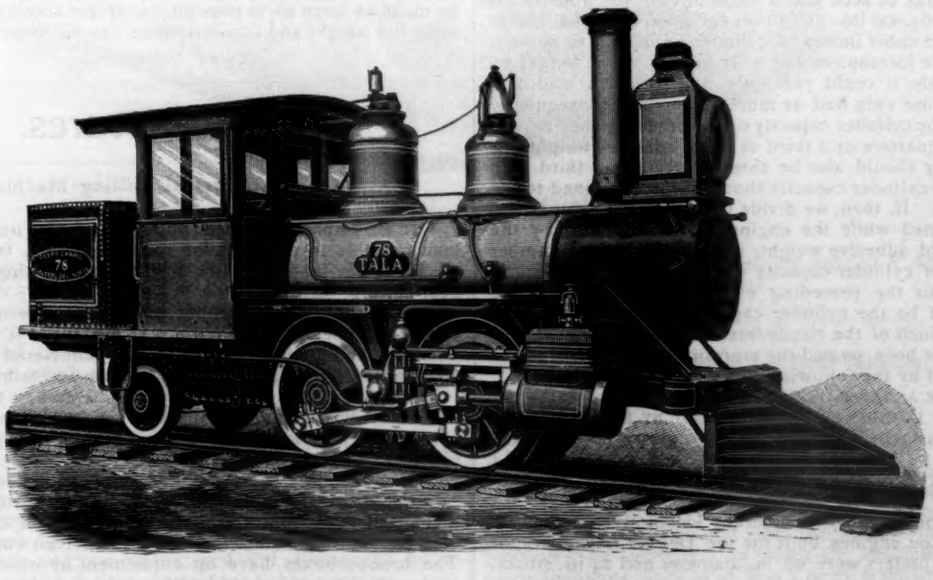
CATECHISM OF THE LOCOMOTIVE.

GRANT PONY LOCOMOTIVE.

BY THE GRANT LOCOMOTIVE WORKS, PATERSON, N. J.

Diameter of driving wheels	4 ft. 2 in.	Diameter of cylinders	14 in.	Number of tubes	126
Diameter of truck wheels	2 " 4 "	Stroke of cylinders	22 "	Outside diameter of tubes	2 in.
Number of driving wheels	4	Length of fire-box, inside	6 ft. 1⅛ "	Length of tubes	7 ft. 10⅛ "
Number of truck wheels	2	Width of fire-box, inside	2 " 9⅜ "	Water capacity of tank	1,498 gals.

NOTE.—The original drawings of this engine were destroyed by the fire at the works in September, 1887, so that full specifications could not be obtained.



FORNEY PONY LOCOMOTIVE.

BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA, PA.

Total weight in working order	36,840 lbs.	Length of fire-box, inside	2 ft. 4 in.	Exhaust nozzles	Double.
Total weight on driving wheels	28,500 "	Width of fire-box, inside	3 " 3½ "	Size of steam-ports	9 × 1 in.
Diameter of driving wheels	3 ft. 1 in.	Depth of fire-box, crown-sheet to top of grate	2 " 10 "	Size of exhaust-ports	9 × 1¾ "
Diameter of truck wheels	2 " 0 "	Number of tubes	97	Throw of eccentric	3½ "
Diameter of main driving-axle journal	4½ "	Outside diameter of tubes	1½ in.	Greatest travel of valve	4⅜ "
Distance from center of front to center of back driving wheels	4 " 6 "	Length of tubes	8 ft. 0¾ "	Outside lap of valve	0¹¹⁄₁₆ "
Total wheel-base of engine	10 " 9 "	Grate surface	7 sq. ft.	Smallest inside diameter of chimney	10 "
Diameter of cylinders	10 "	Heating surface, fire-box	33 " "	Height, top of rail to top of chimney	11 ft. 6 "
Stroke of cylinders	16 "	Heating surface, tubes	300 " "	Height, top of rail to center of boiler	4 " 6 "
Outside diameter of smallest boiler ring	34 "	Heating surface, total	333 " "	Water capacity of tank	450 gals.

$$\frac{64.000}{4} = 16{,}000 \times 207.3 = 3{,}316{,}800,$$

and $$150 \times .90 \times 4 \times 24 = 12{,}960,$$

and $$\frac{3{,}316{,}800}{12{,}960} = 255.9 = \text{area of cylinder.}$$

Having the area the diameter can readily be ascertained by calculation, or from a table of diameters and areas. In this case the diameter is 18 in. very nearly.

QUESTION 618. *What are the three elements which determine the size of the cylinders?*

Answer. From what has been said it will be seen that the size of the cylinders is governed by, first, the weight on the driving-wheels; second, the diameter of those wheels; and, third, the steam pressure.

QUESTION 619. *Are the sizes of cylinders generally determined by these considerations?*

Answer. No; many locomotive superintendents regard the expansive action of the steam in the cylinders as of more importance in determining their size than any other consideration, and therefore they make the cylinders larger than the above rule would indicate they should be. In other cases cylinders are made of considerably smaller sizes than would be given by the rule. Caprice and prejudice seem to have had considerable influence in determining the proportions of cylinders.

QUESTION 620. *In what way can we compare the relative sizes of cylinders, taking into account the weight on the driving-wheels, their size, and the steam pressure?*

Answer. The method of doing this can be best explained by taking, as an example, a standard passenger locomotive with cylinders 18-in. diameter and 24-in. stroke, driving-wheels 5½ ft. = 66 in. diameter, and with 64,000 lbs. of load on these wheels. The circumference of such wheels is 207.3 in., and if they do not slip the locomotive will move that distance on the rails while they revolve once. At the same time each piston will sweep through its cylinder twice, and therefore during one revolution of the wheels four times one cylinder full of steam is used. The cubical space that a piston 18 in. diameter and 24-in. stroke sweeps through in moving from one end of the cylinder to the other is equal to 6,107 cubic inches, so that in one revolution of the wheels $6{,}107 \times 4 = 24{,}428$ cubic inches of steam are used. If, then, we divide 24,428 by 207.3 in., the distance that the locomotive moves during one revolution of its driving-wheels, it will give us the amount of steam used to move the locomotive and train one inch. That is, $24{,}428 \div 207.3 = 117.8$. It will thus be seen that a locomotive of the dimensions given, and with 64,000 lbs. or 32 tons (of 2,000 lbs.) of adhesive weight, has 117.8 cubic inches of cylinder capacity * to move it one inch. If the locomotive had only half as much weight on the driving-wheels, it could pull only half as much load, and would therefore use only half as much steam, and consequently need only half the cylinder capacity of the other locomotive. If there was three-quarters or a third as much adhesive weight, the cylinder capacity should also be three-quarters or a third. In other words, the cylinder capacity should be proportioned to the adhesive weight. If, then, we divide the number of cubic inches of steam consumed while the engine moves one inch by the number of tons of adhesive weight, it will give us the number of cubic inches of cylinder capacity per ton of adhesive weight. Applying this to the preceding example, $117.8 \div 32 = 3.68$ cubic inches will be the cylinder capacity per ton of adhesive weight and per inch of the circumference of its driving-wheels. This quantity has been named the *modulus of propulsion*, which can be calculated by the following rule:

MULTIPLY THE AREA OF ONE PISTON (IN SQUARE INCHES) BY THE STROKE (IN INCHES) AND THE PRODUCT BY FOUR. DIVIDE THIS PRODUCT BY THE CIRCUMFERENCE OF THE DRIVING-WHEELS (IN INCHES) AND BY THE WEIGHT (IN TONS OF 2,000 LBS.) ON ALL THE DRIVING-WHEELS. THE QUOTIENT WILL BE THE MODULUS OF PROPULSION.

This varies considerably in different locomotives. Thus in some consolidation engines built for the Denver & Rio Grande Railroad, the cylinders were 20 in. diameter and 24-in. stroke, the wheels 46 in. diameter with 103,000 lbs. of weight on them. The modulus of propulsion on these engines is 4.05, instead of 3.68, as in the other case.

To get a measure of the cylinder capacity which will also take the steam pressure into account, we should divide the modulus of propulsion by the maximum boiler pressure per square inch. This quantity has been named the *modulus of traction*. Thus in the first example the boiler pressure was assumed to be 150 lbs., and therefore $3.68 \div 150 = .02453$, in the second it was 140 lbs., so that $4.05 \div 140 = .02893$. Experience seems to indicate that a modulus of traction of about .025 will give very good results in practice.

It should be remarked here that it is unimportant, so far as the power of the locomotive is concerned, whether the cylinders have a large diameter and a short stroke or a small diameter and a long stroke, provided the cubical contents are the same. Thus, cylinders 17½ in. in diameter and with 20-in. stroke would have almost exactly the same capacity, and the same power would be exerted with them as with cylinders 16 × 24 in.; the only difference would be that with the cylinder of the largest diameter the pressure on the piston, and consequently on the crank-pin journal, and the strain on the parts would be greater than with the smaller cylinder. The difference in pressure would, however, be exactly compensated by the loss or gain in the leverage exerted through the driving-wheels on the rails.

QUESTION 621. *What circumstances should determine the size of locomotive boilers?*

Answer. They should be proportioned to the amount of adhesive weight, and to the speed at which the locomotive is intended to work. Thus, a locomotive with a great deal of weight on the driving-wheels could pull a heavier load, and would, by the above rule for proportioning the cylinders, have a greater cylinder capacity than one with little adhesive weight, and would therefore consume more steam, and therefore should have a larger boiler. It is also obvious that if a locomotive like that shown in Plates I and II should have a boiler just large enough to furnish steam when running at the rate of 20 miles an hour, it would be too small if the locomotive ran 40 miles an hour, the train resistance being the same in both cases. Driving-wheels 5 feet in diameter would at 20 miles per hour make 112 revolutions per minute, and would therefore consume 448 cylinders full of steam. At 40 miles per hour double the number of revolutions would be made, and consequently twice the quantity of steam would be used, and therefore the boiler should have twice the steam-producing capacity. If, therefore, we know the size of a boiler required for a given amount of adhesive weight and a given speed, we can easily calculate the boiler capacity for any other weight and speed.

QUESTION 622. *What circumstances usually determine the size and proportion of locomotive boilers?*

Answer. The weight and dimensions of locomotive boilers are in nearly all cases determined by the limits of weight and space to which they are necessarily confined. It may be stated generally that *within these limits a locomotive boiler cannot be made too large.* In other words, boilers for locomotives should always be made as large as is possible under the conditions that determine the weight and dimensions of the locomotives.

(TO BE CONTINUED.)

* The cylinder capacity is the space swept through by the two pistons. In the above illustrations what is meant is, that the average space in the cylinder swept through by the piston is 117.8 cubic inches for each inch that the locomotive advances.

Manufactures.

A New Universal Milling Machine.

THE accompanying illustration shows a new universal milling machine. It is designed for boring, drilling, facing, milling, profiling, key-seating, cotter-drilling, rack-cutting (any length), gear-cutting, etc.

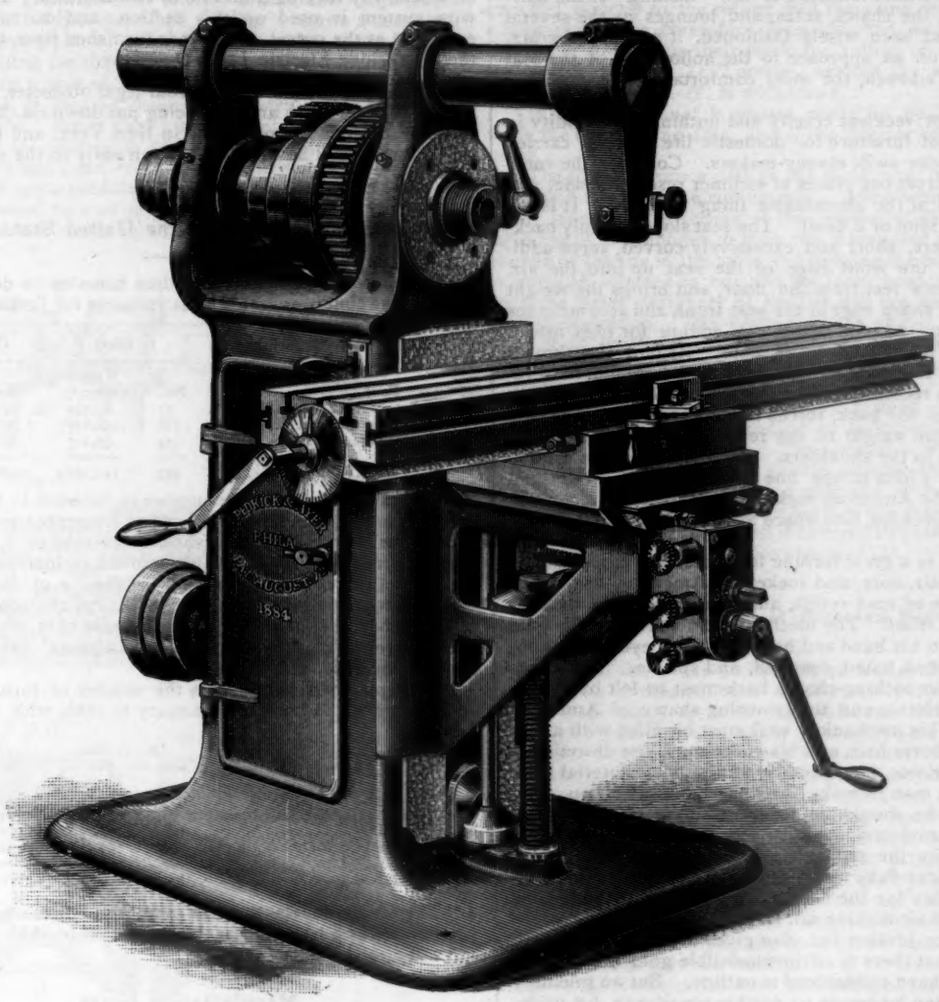
The gearing is made either internal or external as desired, the internal being 4 to 1 and external 8 to 1; it is driven by a 3-in. belt on a 4-step cone, the largest diameter of which is 11 in. All running parts have oil tubes and are accessible for oiling.

The spindle is of extra quality hammered cast steel, and runs in bronze boxes. The front bearing is 3 in. in diameter and 4½ in. long; back bearing 2 in. diameter and 4 in. long, and provided with easy means of adjustment for wear. The front end of the spindle is threaded on the outside for face-plates or face-mills. In the spindle is a taper hole for cutter arbors 1½ in. diameter at the front end, diminishing ⅛ in. in 12 in, to 1 1/16 in. diameter, through which the arbors are driven out by a rammer. The bronze boxes have an adjustment by which the original centers are always retained without altering their position laterally—this is a very important point, as the journal and bearing wear always in the same place. In all other sleeve bearings, when wear is taken up by moving either the box or spindle laterally, a new position is taken and wear commences and takes place very fast. This style of bearing overcomes this entirely.

The cutter-arbor supporting bar, with its adjustable center, can be moved out to support cutter-arbors from the end of the spindle or pushed back out of the way, thus facilitating the milling or boring of a large piece of work that would be prevented by the ordinary fixed bar. It is 3½ in. diameter, and of solid cast steel, making a very rigid support. A harness is furnished for the bar, to fasten to the knee of machine when large cutters

are used on extra heavy work; this is a feature that adds to its value, as can be readily seen.

The three feeds, vertical, horizontal (in line with spindle), and transverse (at right angles to spindle), are all *reversible*, and are operated or stopped altogether by the handle shown in the cut near the cupboard board. This reversing device is common to engine lathes, does away with the crossing of belts and saves



NEW UNIVERSAL MILLING MACHINE.

time. The 3-step cone on the spindle belts to the lower cone, the shaft of which runs in a hollow stud and drives, by means of the reversing device referred to above, a shaft running through the base of the column. Bevel gears connect this shaft with the vertical shaft, and the latter by bevel gears with the horizontal shaft in the knee, which communicates in turn with the several screws for the various feeds in the front of the knee by clutch gears. These clutch gears can be engaged or disengaged at will by the knurled knobs shown in front, giving a vertical or horizontal feed. The platen feed is operated from the upper shaft in the knee by means of a pair of miter wheels running in a bearing which is a part of the platen slide on the knee. A vertical stud passes upward to the long screw in the platen, and is connected to it by clutch miter wheels. The screw in the platen is splined, and can be engaged and disengaged by a clutch lever, shown in the cut, convenient to the operator.

The platen is 48 in. long, 9¼ in. wide, and has two slots for ⅝-in. bolts on the top and on the edges two slots. The latter are very useful and convenient. The platen has a transverse feed of 33¼ in. and a horizontal feed of 7¼ in. It can be turned completely around and fed in line with the spindle. It has an automatic stop, while feeding in either direction, and is secured by four ⅝-in. steel bolts in the swivel base, of easy access with a wrench.

The knee is so designed and constructed as to withstand all strains liable to be brought upon it. It has a bearing 17 in. long and 10½ in. wide.

The feed gearing is well protected from dirt, and the mechanism is not liable to disarrangement. All gears and screws are of steel, and are accurately cut. The dials read in decimals, or divided by 2, 4, 8, etc., enabling any measurement to be made.

The base of this machine is 30 by 40 in., and the spindle is 42 in. from the floor. The total weight of the machine is 2,600 lbs.

This is a very useful tool in the shop, owing to its wide range of work. It is manufactured by Pedrick & Ayer, at No. 1025 Hamilton Street, Philadelphia.

A Fortune for Seat-Makers.

(From the New York *Sun*.)

THOUSANDS of models of a perfectly comfortable seat will be made this winter in the Northern States by healthy boys playing in snow-banks. They will cast themselves backward against the slope of the drifts, and sink and wriggle themselves into a position of heavenly rest, in which the absolute content of the head, shoulders, back, and legs allures body and soul to slumber, even in a temperature of zero. And there is not a chair-maker in this smartest of nations smart enough thus far to have made a chair on the lines left in the snow-bank by the boy's body.

For forty-five years the male American's experience of chairs and other furniture to sit on has been a martyrdom to ignorance and fashion. Their convex surfaces may be the deserved punishment of our national sin of permitting unrestricted immigration. They came from Germany, and were the treacherous gift of German upholsterers to the confiding republic that welcomed and fostered them. By reason of the convexity of the seats, there is not in any well-furnished parlor in this city a comfort-

able chair or sofa. To sit on them is to sit on a globe or a cannon-ball. The seat should always be hollow.

We recall at this instant the administrator's sale in Albany of the furniture of the great John C. Spencer, ex-Secretary of the Navy, and of nearly every other department in Washington, and we remember the admiration by the most intelligent crowd in the great State Street mansion of the "dishing" of the hair-cloth seats of all the chairs, sofas, and lounges in the several rooms. They had been wisely fashioned, it was said by Mr. Spencer himself, on an approach to the hollowness of the seat of the shoemaker's bench, the most comfortable seat man has ever sat on.

But the palm for reckless cruelty and unthinking stupidity in the manufacture of furniture for domestic life is easily carried off by our American swift money-makers. Consider the rocking-chair which curses our places of summer resort, seaside, and mountain. Look at the abominable thing laterally! It is the contrivance of an idiot or a devil. The seat slopes steeply backward. The rockers, short and excessively curved, serve additionally to throw the front edge of the seat up into the air. This lifts the sitter's feet from the floor, and brings the weight of the legs on the sharp edge of the seat front, and accomplishes a torture which no human being can endure for over fifteen minutes without an outcry or an oath. Regard the thing's back! A recess, too deep by half, invites the shoulders to repose. Below this recess a malicious bulge in the structure jams the tender small of the back, forces the lower part of the spine to sustain the entire weight of the reclining trunk, and defeats possibility of rest to the shoulders. It must have been a Puritan cabinetmaker's idea of the line of beauty that established the curvature of the American rocking-chair's back, which from the shoulders up recedes into space and mockingly refuses the weary head.

Certainly, there is a great fortune for somebody in a perfectly restful seat on chair, sofa, and rocker for American use. The nation is in a state of mad revolt, and in a mood to be reckless about the price of relief. The mechanic who starts for this gold mine must carry in his hand and hold before his eyes the "convex" utterly smashed, hated, despised, and spit on. The established model of our rocking-chair's back must be felt by him to be the unpardonable sin and the crowning shame of American household art. This mechanic's soul must be filled with a reverence for curled horse-hair, and his gorge must rise chronically against moss, excelsior, tow, shoddy, and rags as material for a seat for an honest man to make for a good man to sit on.

Thus equipped, he should go reverently to a country snow-bank, and fill his soul and memory with the lines of the heavenly rests made by the red-cheeked, wholesome boys in the yielding slopes of the flaky walls, and carefully take their measurements and angles for the fixed principles and unchangeable rules of his new chair-making art.

To this unknown brother the *Sun* gives the New Year's gift of its assurance that there is an inexhaustible gold mine in the chair and seat we have endeavored to outline. But we solemnly warn him that, when he ceases to put his conscience, his pride, his ambition, and his hopes of the future into his work, and begins to cheapen it in a greed for quick wealth and unearned profits, the side walls of his golconda will swiftly draw together and he and his gold will be petered out.

Electric Notes.

A SHORT time ago the Julien Electric Company expressed a hope that by its new method of regulations it could so economize the use of the current from its battery as to make three round trips, or 36 miles, with one charge on the Fourth and Madison avenues line in New York. It now reports that this has been accomplished, and that the large 18-ft. cars, carrying unusually heavy loads of passengers, are now making three round trips, from 86th Street to the Post-Office and back (or 36 miles), without any change of battery. It now changes the battery but once a day, thus making a great saving in time. Not content with this performance, the Julien Company hopes to be able to make a fourth trip, or 48 miles, on one charge, inasmuch as it finds that at the end of the third trip the voltage of the battery is still above two volts per cell. It is claimed that the trip from 86th Street to the Post-Office and back, 12 miles, is made on an expenditure of less than 15 electrical H.P. hours, or 36 miles on 45 electrical H.P. hours. Calculating the cost at 2 cents per H.P. hour, the Julien Company computes that it costs but 30 cents for energy in a round trip of 12 miles, or 2½ cents per mile. Assuming 75 miles for a car-day the cost would be $1.87½. The Company gives these data from its books at their electrical station, and invites inspection, the records showing the ampère-hours and the H.P. hours put into the battery each day, and the cost of the same.—*Electrical Engineer.*

THE Thomson-Houston Electric Company has equipped the Cambridge Division of the West End Street Railroad, Boston, with its motor. This division extends from Bowdoin Square, Boston, to Harvard Square, Cambridge, three miles, and thence four miles further through North Avenue to Arlington. On the first division of three miles the traffic is large, and the cars run on a headway varying from one to two minutes. The overhead-wire system is used on this section, and 20 cars are to be equipped at the outset. Power is furnished from the station of the Cambridge Electric Light Company.

AFTER long delays, arising from legal obstacles, the conduits for the electric wires are now being put down on the cross-town railroad through Fulton Street in New York, and it is expected that the road will be in full operation early in the spring.

Blast Furnaces of the United States.

THE *American Manufacturer* thus sums up its detailed statement of the condition of the blast furnaces on January 1: "The totals are as follows:

	In Blast.		Out of Blast.	
Fuel.	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal	71	13,213	97	11,386
Anthracite	108	31,837	88	22,297
Bituminous	154	97,117	71	31,964
Total	333	142,167	256	65,647

"Our table shows that the number of furnaces in blast on January 1 was 333, compared with 331 on December 1—an increase of 2. The charcoal furnaces show a decrease of 2, the anthracite an increase of 1, and the bituminous an increase of 3, making the net increase 2. The weekly capacity of the furnaces in blast was 142,167 tons, compared with 139,282 tons on the 1st of December. This shows a net increase of 2,985 tons—charcoal, decrease, 57 tons; anthracite, increase, 787 tons; bituminous, increase, 2,157 tons.

"The appended table shows the number of furnaces in blast on January 1, 1889, and on January 1, 1888, with their weekly capacity:

	Jan. 1, 1889.		Jan. 1, 1888.	
Fuel.	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal	71	13,213	73	13,237
Anthracite	108	31,837	117	35,259
Bituminous	154	97,117	151	92,224
Total	333	142,167	341	140,720

"This table shows that the number of furnaces in blast on January 1 was 8 less than at the same date in 1888."

Manufacturing Notes.

RECENT shipments made by the Betts Machine Company, Wilmington, Del., include a large horizontal boring and drilling machine to the Louisville & Nashville shops at Decatur, Ala.; a large boring mill and a 60-in. planer to San Francisco; and two heavy frog planers, weighing 60,000 lbs. each, to the Ramapo Iron Works of Hillburn, N. Y.

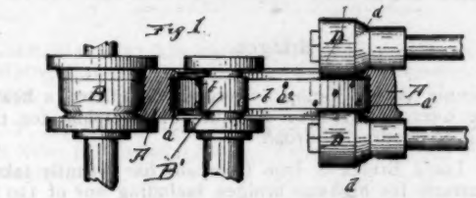
THE contract for the steel forgings for the 8-in., 10-in., and 12-in. guns for the Army has been awarded to the Bethlehem Iron Company, at Bethlehem, Pa., the price varying from 24 to 27½ cents per pound. The first set of 8-in. forgings is to be delivered within 18 months, and the work is to be finished in three years; the 10-in. forgings will require nearly five years, and the 12-in. forgings six years for their completion. The contract includes the steel for 21 guns of 8-in. caliber, 22 of 10-in., and 14 of 12-in. The Midvale Steel Company, Philadelphia, received the contract for 25 sets of forgings for 3.2-in. steel field guns at 35 cents per pound, delivery to be made within nine months.

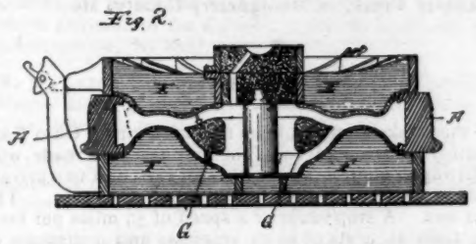
THE Westinghouse Machine Company reports that its sales for the four months ending November 30 include 33 compound engines aggregating 4,070 H.P.; 88 standard engines aggregating 4,060 H.P.; and 141 "junior" engines aggregating 3,500 H.P., a total of 262 engines. The compound engines were mainly of large size, 26 of them being of 100 H.P. or over. The engines were furnished for almost every description of business, including machine shops, mills of all kinds, electric-light stations, hoisting engines, etc. These orders also include a number of engines for export to France, Russia, Cuba, and other countries.

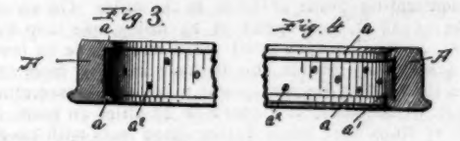
New Method of Making Steel-Tired Wheels.

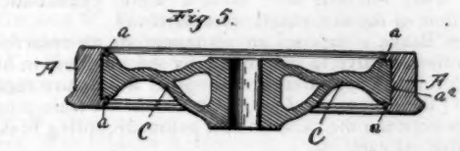
THE accompanying illustrations represent a method of making steel-tired car wheels in which the tire is first rolled and the center is cast within it. The inventor proposes to roll the tire, and to put it in the mold while still hot, so that no reheating will be needed. He prefers for the tire a hard and tough steel.

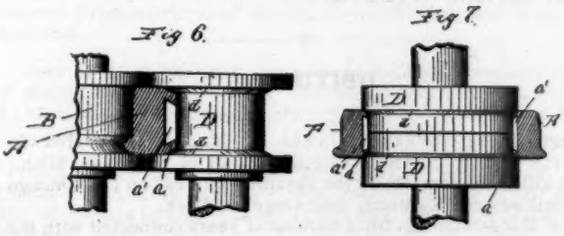
The invention is thus described: "Fig. 1 shows a sectional view of a tire and a pair of box-rolls in elevation, such as may be used for rolling the tire with the plain interior flanges, and also in elevation a pair of edging-rolls having bevelled collars suitable for use in turning down the flanges, so as to form a dovetailed groove. Fig. 2 shows a sectional view of the tire in the mold ready for pouring in the molten iron to form the cast center. Figs. 3 and 4 are cross-sections of the tire before and after the flanges are turned down to form the dovetailed groove. Fig. 5 is a sectional view of the wheel as produced by my process. Fig. 6 shows a single roll having a pair of conical collars,











and which operates, in conjunction with an ordinary box-roll, to incline the interior flanges of the tire. Fig. 7 shows a pair of dies with bevelled faces for pressing down the interior flanges of the tire. Similar letters of reference indicate like parts in all the figures.

"In the drawings, *A* represents the tire; *a a*, the interior flanges; *a'*, the interior dovetailed groove formed by inclining the flanges *a a* toward each other. The flanges are rolled upon the tire by box-rolls *B B'*. The interior box-roll, *B'*, is provided on its periphery with one or more small projections, *b*, which serve to make a number of indentations on the interior peripheral surface of the tire. The molten metal of the cast-iron center, *C*, flowing into these indentations a^3 in the tire, serves to more rigidly connect and fix the center and tire together.

"*D D* represent a pair of edging-rolls having bevelled shoulders, *d d*, adapted to bear against the flanges *a a* and bend or incline them toward each other. In fig. 6 a single vertical roll, *D*, having two bevelled shoulders or collars, *d d*, operates in conjunction with the box-roll *B* to accomplish the same purpose.

"In fig. 7 the tire, after being swung from the rolling-mill, is placed in a stamp or press between two dies, *D D*, having bevelled shoulders *d d*.

"The means indicated in fig. 1 are those preferred for inclining the interior flanges of the tire, as the pair of rolls *D D* may be attached directly to the rolling-mill the same as ordinary plain edging-rolls have heretofore been attached, and after the box-rolls *B B'* have done their work the rolling of the tire is completed and the rolls *D D* pressed against the tire the moment the interior box-roll, *B'*, is withdrawn.

"In fig. 2 the mold is shown ready for pouring. *E* represents the cope, *F* the drag, and *G* the interior of the core of the mold.

"The tire *A* forms a part of the mold, and is placed therein while still hot from the rolling-mill. After being rolled the tire is not reheated, the rolling of the interior of the flanges *a*, the inclining of said flanges to form the dovetailed groove, and the placing of the tire in the mold and forming the cast center therein being all effected in one and the same heat, so that the chill upon the outer periphery of the tire will not be injured by the casting operation. The casting of the center within the tire will not of itself so raise the temperature of the tire as to destroy or injure the chilled and hardened surface produced by the rolls upon the tread of the tire.

"The dovetailed groove may be formed on the interior periphery of the tire by bending or inclining only one of the two flanges instead of both. The preferable way, however, is to incline both flanges, as it makes a better shaped dovetailed groove than is made by inclining only one of them."

This method of making car wheels is the invention of James Munton, of Maywood, Ill., and is covered by patent No. 390,695, issued to him under date of October 9, 1888.

The Widdifield & Bowman Brake.

A TRIAL of this brake on the Lehigh Valley Railroad on January 10 was witnessed by a number of invited guests. The freight train equipped with the brake ran from Metuchen to Flemington Junction and back, making ordinary service stops, emergency and breakaway stops very successfully.

This brake is a momentum brake, with electrical attachment for throwing it into action simultaneously on every car on a train. The essential features of the brake consist of a composite sleeve cast on to the car axle, upon which work two friction pulleys, properly geared, and thrown into action by an impulse of electric current; by these friction pulleys a chain gear is wound, which applies the brakes to the car wheels. The electricity is stored in cells, which are placed on the engine and rear car, and carried along the train by an insulated wire cable suitably coupled between each car.

The brake is controlled from either end of the train. In case the train is accidentally broken in the middle, the brakes apply all along the train automatically and in an instant, and the brakes on each section of the train can be released instantaneously, although the train is separated, as the independent electric circuits remain in each section, leaving absolute control of the forward section at the engine, and of the rear section at the caboose or rear car. Cars that are not fitted up with the brake may be taken into the middle of the train and switched out at will without interfering with the operation of the brake from either end of the train.

Marine Engineering.

THE Bowers dredger that has been built at San Diego is one of the largest ever constructed in this country. Its length is 120 ft., beam 32 ft. The drilling and pumping machinery is located in the stern, where there is a long shaft through which works an iron apparatus 27 ft. long and 77 in. wide.

Under it is suspended a 20-in. suction pipe, at the end of which works the Bowers excavator, consisting of a mammoth iron screw 4 ft. in diameter, which bores into the sand, throwing out a cubic yard of earth at each revolution. The propelling machinery is driven by a 30 H. P. engine. The ladder is lowered and raised by a 20 H. P. engine. On the left of the ladder near the center of the dredger is a suction pipe, which coming up from the screw at the bottom turns into a slip-joint, and is carried back to the center of the dredger, where the pipe connects with an immense circular pump 6 ft. in diameter, and rotating with a velocity of 400 ft. per minute. The pump is driven by a 250 H. P. Westinghouse engine, having a 20-in. cylinder and 16-in. stroke. This is the largest Westinghouse engine ever

built. The pump can force sand through pipes over a mile.—*Pacific Lumberman and Contractor.*

THE Centennial Transportation Company, of New York, are having a twin screw steamer built by J. Ellis & Son, of Tottenville, S. I., to run between Sea Bright and New York next season. Her dimensions are 105 ft. keel, 114 ft. over all, 21 ft. 6 in. hold, and estimated draught 3 ft. 9 in. light. She will have two sets of triple expansion engines, built by Sullivan, the high-pressure cylinders of which are 6½ × 10 in. They are expected to make 300 revolutions per minute, with 350 lbs. of steam, the steam to be supplied by a pair of Roberts' safety water tube boilers, having in the aggregate about 44 square feet of grate and nearly 1,300 square feet of heating surface. They will carry a working pressure of 250 lbs. of steam on natural draught. —*Marine Journal.*

THE W. & A. Fletcher Company has taken the contract for a new steel ferry-boat for the Union Ferry Company, of Brooklyn.

Locomotives.

THE Rogers Locomotive Works, Paterson, N. J., are building 18 locomotives, with 18 × 24-in. cylinders and 63-in. driving-wheels, for the Eastern Railroad of Minnesota.

THE Richmond Machine & Locomotive Works, Richmond, Va., are building additional shops and putting in new tools with the intention of increasing their capacity for building locomotives to 100 a year.

THE Cooke Locomotive Works in Paterson, N. J., being unable to secure additional room on the site at present occupied, have purchased land in a much more convenient location, adjoining the Erie tracks in Paterson, where they are now erecting extensive and well-arranged buildings for their shops.

DURING 1888 the Baldwin Locomotive Works, Philadelphia, largely exceeded any previous yearly output, the number of locomotives built being 737. Of these, two were of special types, one being a handsome locomotive and car combined for the Government of Nicaragua, and one a rack-rail locomotive for a Brazilian railroad. Of these engines 188 had two pairs of driving-wheels connected, 275 had three pairs of driving-wheels coupled, and 272 were of the consolidation type, with four pairs of coupled wheels. The latter included two locomotives with 21 × 26-in. cylinders and 21 with 22 × 28-in. cylinders. In all 93 locomotives were exported to the following countries: Australia, Brazil, Canada, Central America, Cuba, Ecuador, Mexico, and New Zealand.

THE Schenectady Locomotive Works furnish the following table showing the locomotives built by them in 1888:

Cylinders.	8-wheel.	10-wheel.	12-wheel.	Consolidation.	Switch. 6-wheel.	Switch. 4-wheel.
14 in.	.....	.....	.....	.....	.....	1
15 in.	.....	.....	.....	.....	.....	2
16 in.	.....	.....	.....	.....	.....	10
17 in.	8	.....	.....	.....	19	.....
18 in.	81	94	.....	.....	19	.....
19 in.	.....	40	.....	.....	4	.....
20 in.	.....	.....	13	10	.....	.....
Totals,	89	134	13	10	42	13

This is a total of 301 locomotives, the largest output ever made by these works in one year. The large proportion of heavy engines is noticeable. The average weight of these 301 engines, exclusive of tender, was 98,000 lbs. The works now employ about 1,500 men.

Cars.

THE Dunham Manufacturing Company, Boston, has made sales of its storm-proof car door recently to the Cleveland, Columbus, Cincinnati & Indianapolis, the Wabash Western, the New Jersey Central, the Union Pacific, and the Milwaukee, Lake Shore & Western roads. The same company reports recent sales of its Globe ventilator to the Boston & Albany, the New York Central, the Memphis & Charleston, and Pullman's Palace Car Company.

THE American Railway Equipment Company has been incorporated in New York for the manufacture of the Stearns patent car box and other standard improvements. The corporators are O. S. Burr, George G. Saxe, A. S. Hatch, Thomas R. White, Jr., O. S. Stearns, Herbert S. Ogden, and Hon. William Fullerton; O. S. Burr, President; A. S. Hatch, Vice-President and Treasurer; Thomas R. White, Jr., Secretary. The capital is $1,000,000.

THE St. Charles Car Company, St. Charles, Mo., did a business in 1888 of the value of $2,200,000, and expended $100,000 in improvements. Besides the passenger coaches and the 3,129 freight cars turned out, 3,000 car wheels were moulded, and 100,000 tons of cast and wrought-iron work completed.

THE Beal's Brake Company, of New York, has recently been reorganized. The newly elected officers are: President, T. B. Atkins; Secretary and Treasurer, R. W. Gilbert; Directors: W. D. Ellis, Dr. Cochran, and H. B. Hammond. Mr. James Howard is retained as General Manager for the new company.

THE South Baltimore Car Works are building for the Baltimore & Ohio Railroad 200 gondola cars, 34 ft. long, and 50,000 lbs. capacity. They will have the American continuous draw-bar. John B. McDonald has been chosen President of these works.

Bridges.

THE Phœnix Bridge Company recently completed a heavy iron bridge over Germantown Avenue, Philadelphia, for the Philadelphia & Reading Railroad.

THE St. Louis Bridge & Iron Company has recently taken several contracts for highway bridges, including one of 120 ft. span over Loutre Creek, in Montgomery County, Mo.

The Boyden Brake.

TESTS of this brake were made on the Baltimore & Ohio Railroad, December 17, 18, and 19. The first test was made with a train consisting of engine, 25 refrigerator cars, and two private cars, the total weight of train being about 590 tons. The weather was wet. A stop made at a speed of 39 miles per hour brought the train to a stand in 24 seconds, and a distance of 920 ft. on a descending grade of 80 ft. to the mile. On an ascending grade of 23 ft. at a speed of 24 miles, one stop was made in 250 ft., and other very good stops were made on level and slightly descending grades, the distance varying from 550 to 620 ft. On the second day a stop was made on a descending grade of 116 ft. to the mile, at a speed of 47 miles an hour, in 965 ft. In all 15 stops were made during these tests with excellent results. After the tests were made a careful examination showed that none of the car wheels were flattened.

The Boyden Brake comprises an air-pump, an air-reservoir on the locomotive, a valve to be worked by the engineer in his cab, a brake for the locomotive, a train-pipe, a pressure regulator to control the compressed air which enters the train-pipe, hose couplings between the cars, and the automatic spring brake device and valve on each car.

OBITUARY.

LIEUTENANT GOVERNOR JAMES H. MACDONALD; HORACE TUTTLE and WILLIAM S. COCHRANE, all of Escanaba, Mich., were killed January 19, by the derailing of a car on the Chicago & Northwestern Railroad, near Gogebic, Mich.

Mr. Macdonald was for a number of years connected with the Chicago & Northwestern road, but for several years past he had been engaged in the management of large iron mining properties in the Lake Superior Region. He was 57 years old, and had just entered on a second term as Lieutenant-Governor of the State.

Mr. Tuttle was also engaged in iron mining, and was President of the Commonwealth Iron Company. Mr. Cochrane was Manager of the works of the Cochrane Iron Mining Company.

PERSONALS.

JOHN B. INMAN is Chief Engineer of the Troy & Tiptonville Railroad, with office at Troy, Tenn.

SAMUEL ROCKWELL has been appointed Chief Engineer of the Eastern Railroad of Minnesota.

COLONEL WILLIAM J. WINN was on January 9 unanimously re-elected City Engineer of Savannah, Ga.

T. W. NICHOL, of Mobile, Ala., is now Chief Engineer of the Mobile, Jackson & Kansas City Railroad.

A. L. STANNARD is Chief Engineer of the Davenport, Iowa & Dakota Railroad, with office at Davenport, Ia.

F. D. WOODBURY, of Waseca, Minn., is Chief Engineer of the Minneapolis, St. Paul & Southwestern Railroad.

G. W. CUSHING has been appointed Superintendent of Motive Power of the Union Pacific Railway, with office at Omaha.

JOHN W. CLOUD has resigned his position as Superintendent of Motive Power of the New York, Lake Erie & Western.

GEORGE LINDOFF has been appointed Master Mechanic of the Montana Union Railroad in place of GEORGE ROSS, who has resigned.

ROSS KELLS succeeds Mr. JOHN W. CLOUD as Superintendent of Motive Power of the New York, Lake Erie & Western Railroad.

CLEM. HACKNEY has resigned his position as Superintendent of Motive Power of the Union Pacific Railway, after three years' service.

J. P. NELSON has been appointed Chief Engineer of the Newport News & Mississippi Valley Company, and has his office in Lexington, Ky.

SAMUEL M. ROWE has been appointed Chief Engineer on the Western Division of the Atlantic & Pacific Railroad, with office at Albuquerque, N. M.

W. H. LEWIS has been appointed Master Mechanic of the Chicago, Burlington & Northern Railroad, in place of H. S. BRYAN, who has resigned.

ARTHUR JOHNSON has resigned his position as Mechanical Engineer of the New York, Lake Erie & Western Railroad. He has been connected with the road for 25 years.

J. G. METCALFE has been appointed General Manager of the Louisville & Nashville Railroad, to succeed Mr. HARAHAN. He has been Superintendent of the South & North Alabama Division.

ALBERT SPIES, for seven years Mechanical Editor of the *Iron Age*, has severed his connection with that journal with the view of taking up professional work. He may be addressed at 901 Summit Avenue, Jersey City, N. J.

GEORGE W. W. HOUGHTON, for 20 years past Editor of the *Hub*, has retired from that journal, and is now Editor of *Varnish*. Mr. Houghton is thoroughly acquainted with the carriage business, and is a writer of ability.

S. B. OPDYKE, JR., late Engineer of Bridges on the New York, New Haven & Hartford Railroad, has been appointed General Superintendent of the Hartford & Connecticut Western Railroad.

JOHN T. RICH has been reappointed Railroad Commissioner of Michigan for another term. He has reappointed WYLLYS C. RANSOM Deputy Commissioner, and CLINTON B. CONGER Mechanical Engineer.

JOHN BLACK has been appointed Master Mechanic of the Chicago & Atlantic Railroad, with office at Huntington, Ind. Mr. Black was formerly on the Cincinnati, Hamilton & Dayton Railroad.

C. W. DAVENPORT has been chosen Chairman of the Erie Car Works, Erie, Pa., to succeed his father, the late WILLIAM R. DAVENPORT. He has been connected with the works for a number of years past.

WATERMAN STONE, for 17 years past Superintendent of the Providence, Warren & Bristol Railroad, has resigned that office to accept the position of General Manager of the Interstate Elevated Railroad at Kansas City.

LIEUTENANT BRADLEY A. FISKE, U.S.N., whose articles on Electricity will be remembered by our readers, is the inventor of the electrical apparatus which will be used in firing the dynamite guns on the new gunboat *Vesuvius*.

D. H. NEALE has accepted an important position in the locomotive department of the Government Railroads of New South Wales. Mr. Neale is well qualified for such a position by his experience and attainments as a mechanical engineer.

SAMUEL SPENCER, who recently retired from the office of President of the Baltimore & Ohio Railroad Company, has, it is stated, accepted the position of Vice-President and General Manager of the East Tennessee, Virginia & Georgia Railroad Company, and will be the chief executive officer in charge of that Company's extensive system of railroads.

PROCEEDINGS OF SOCIETIES.

National Geographic Society.—This society held its annual meeting for election of officers, presentation of reports, etc., December 28. The Secretaries and Treasurer presented their annual reports, and officers were elected for the year 1889 as follows: President, Gardiner G. Hubbard; Vice-Presidents, H. G. Ogden, G. L. Dyer, A. W. Greely, C. Hart Merriam, A. H. Thompson; Treasurer, C. J. Bell; Secretaries, Henry Gannett, George Kennan; Board of Managers, Cleveland Abbe, Marcus Baker, Rogers Birnie, Jr., G. Brown Goode, C. A. Kenaston, W. B. Powell, O. H. Tittmann, J. C. Welling.

American Geological Society.—A large number of geologists met at Cornell University, Ithaca, N. Y., December 27, in response to the call to organize a permanent society of geologists. A constitution was adopted, and the permanent organization will be known as the American Geological Society, its object being the promotion of the science of geology in North America. The society has 126 members, all of whom are working geologists.

These officers were elected: President, Professor Hall; Vice-Presidents, J. D. Dana and Professor Winchell; Secretary, Professor J. J. Stevenson; Treasurer, H. S. Williams, of Cornell. The membership of the society is to be limited to prominent geologists, and each member is to have the privilege of using the title F. A. G. S. (Fellow of the American Geological Society). The meeting was formally adjourned to meet in Toronto in the early part of next August.

American Institute of Mining Engineers.—The nineteenth annual meeting will be held in New York City, beginning Tuesday evening, February 19, 1889.

The following programme is provisionally announced:

Tuesday, February 19—Evening: Opening session.

Wednesday, February 20—Morning and Afternoon: General excursion to the Spiral Weld Tube Works and the Edison Laboratory, at East Orange, N. J., with a session at the Edison Laboratory devoted to the Applications of Electricity in Mining. A paper is promised from Mr. Edison.

Evening session devoted to papers and discussions connected with iron and steel.

Thursday, February 21—Morning and Afternoon: Sessions at which, if the Council so decides, the subjects of the Wednesday evening session may be continued. At the afternoon session the election of officers and other business will be transacted. Evening: Subscription dinner.

Friday, February 22—Morning and Afternoon: Numerous local excursions, in parties, according to the preferences of individual members. Evening: Social reception.

Saturday, February 23—Morning and Afternoon: Local excursions.

Mr. R. P. Rothwell, editor of the *Engineering and Mining Journal*, has special charge of the programme of the session of Wednesday, devoted to Electricity in Mining, and Mr. Charles Kirchhoff, Jr., editor of the *Iron Age*, has special charge of the programme of the session or sessions devoted to Iron and Steel. Members intending to present papers on these subjects should correspond with Mr. Rothwell or Mr. Kirchhoff, according to the nature of their papers, notifying the Secretary of the Institute also of their intention.

Society of American Naturalists.—This Society has chosen the following officers for the ensuing year: Professor George L. Goodale, Harvard University, President; Professor G. Brown Goode, Smithsonian Institution, Vice-President; Professor Henry H. Donaldson, Johns Hopkins University, Secretary; Professor William T. Sedgwick, Massachusetts Institute of Technology, Treasurer: Rev. J. P. McMurray, Haverford College, Professor George H. Williams, Johns Hopkins University, Executive Committee. A communication was read from the Zoological Society of Paris, stating that it is organizing an International Zoological Congress to convene about August 1, in some place not yet determined upon, and requesting the co-operation of all naturalists.

United States Naval Institute.—At the meeting held in Annapolis, January 4, Commander P. F. Harrington delivered a lecture on the Ram as a Naval Weapon. After an interesting statement of experience he reached the following conclusions as to future naval warfare:

"1. The torpedo-boat will be confined to operations in the immediate vicinity of harbors, and its usefulness will be limited, if not destroyed, by a moderate sea or swell.

"2. Whenever two or more ships are associated, the principal battle order will be formed by the heavier vessels of great offensive and defensive qualities.

"3. The tactics of the principal battle line will assimilate the long-recognized principles of fleet tactics, but modified by the presence of the ram and the torpedo. The unity and mutual support of this line will in general forbid the attempts of individual ships to employ the ram and limit them to the gun as the chief weapon.

"4. An auxiliary force will be associated with the principal battle line. From all the vessels of a naval force, smaller than the battleships and not otherwise suitable for a place in the battle line, those will be selected for auxiliaries which upon comparison are judged to possess the greatest speed and handiness, combined with the greatest protection to machinery and stability. These are the torpedo rams to be manœuvred by separate tactics. They will be with, but not of the line of battle."

Franklin Institute.—The subjects for the lectures in the regular course during February, are:

February 4: Bearing Metal Alloys; Dr. Charles B. Dudley.

February 11: Amateur Photography; Professor Charles F. Himes.

February 18: Some New Points in Chemical Theory; Dr. T. Sterry Hunt.

February 25: Blindness and the Blind; Dr. L. Webster Fox.

American Society of Civil Engineers.—At the regular meeting of December 19, a communication was read from the English Society of Arts extending an invitation to the American Society of Civil Engineers to visit them next year.

The Secretary announced that Dr. Wolfred Nelson would deliver a lecture on the Panama Canal, December 21, in Chickering Hall. The Secretary exhibited photographs of specimens of timber that had been treated by various processes, and read an accompanying report.

Francis Collingwood, J. F. Flagg, Theodore Cooper, and John Bogart discussed the ravages of the teredo and the details of the protective processes. Subsequently State Engineer John Bogart exhibited drawings of three types of lift-bridges over the Erie Canal.

AT the regular meeting of January 2 the topic of the evening was the discussion of High Dams to Resist the Pressure of Water. A discussion was read by E. Sherman Gould, and one was read by the Secretary for Professor E. A. Fuertes. These discussions related mainly, if not entirely, to the paper on High Dams, read some months before by James B. Francis, but the oral discussion that followed gravitated to the question of curved dams in general and the proposed Quaker Bridge Dam in particular. Messrs. Buck, Collingwood, Croes, Davis, Emery, Flagg, Fteley, Wellington, and Whistler, took part, and the discussion was quite animated.

The following gentlemen were announced as elected:

Members: Winthrop Bartlett, St. Louis, Mo.; Charles Addison Ferry, New Haven, Conn.; John Leland FitzGerald, Greenbush, N. Y.; Charles Wingate Gibbs, Silverton, Col.; Edward A. Handy, Cleveland, O.; George Alexander Keefer, Victoria, B. C.; James Warren Pearl, Canton, O.; John Charles Quintus, Erie, Pa.; Lewis F. Rice, Boston, Mass.; William Benson Storey, Jr., Carbonado, Wash.; William Henry Wentworth, Monterey, Cal.; Nuevo Leon, Mexico.

Associate: John Elfreth Watkins, Washington, D. C.

Juniors: Ysidori Ygnacio Polledo, Cardenas, Cuba; Charles t. John Warner, New York City.

THE 36th annual meeting began at the Society's house in New York, January 16. The report of the Committee on Standard Time was presented by Mr. Sandford Fleming, who reported progress made toward securing the adoption of the 24-hour notation for time.

A paper discussing the report of the Committee on the Relation of Car Wheels to Rails was presented by Mr. Don M. Whittemore.

It was announced that the British Institution of Civil Engineers had offered its services to the delegation of the American Society, which will attend the Paris Exposition. Other routine business was transacted.

It was announced that the Rowland prize of $50 had been awarded to Clemens Herschel, of Holyoke, Mass., for his paper on the Venturi Water-Meter. The Norman gold medal has been awarded to E. E. Russell Tratman for his paper on English Railroad Track.

The following officers were announced as elected for the ensuing year: President, M. J. Becker, Pittsburgh; Vice-Presidents, A. Fteley, New York, and E. L. Corthell, Chicago; Secretary and Librarian, John Bogart, New York; Treasurer, George S. Greene, Jr., New York; Directors: Charles B. Brush, New York; Eliot C. Clarke, Boston; Walter Katte, New York; Robert E. McMath, St. Louis, and William P. Shinn, Boston.

On the second day of the meeting the morning was spent by the members present in visiting the new Manhattan Bridge over the Harlem River, the yards and other works of the Dock Department, the freight transfer stations of the New York Central Railroad, the Brooklyn Bridge, and the new gas-holder of the Consolidated Gas Company, which is said to be the largest in the world. In the afternoon a meeting was held, at which a number of papers were presented.

The evening was devoted to the annual reception of the Society, at which a large number of members and invited guests were present.

The Engineers' Club.—The regular meeting of this Club was held in New York, January 15, Vice-President Henry R. Towne in the chair. There were between 50 and 60 members present.

Mr. Towne stated briefly the objects of the Club and the business of the meeting, and announced that the election of officers would be deferred till a later meeting.

Resolutions offered by Dr. Egleston were adopted, authorizing the present Board to provide suitable quarters for the Club. There was some informal discussion on the location of the clubhouse. Mr. Williams, the Secretary, read a list of the gentlemen already members, and announced that a number of others had signified their wish to join the Club.

Canadian Society of Civil Engineers.—At the annual meeting in Montreal, January 17, the retiring President, Mr. T. M. Keefer, presented his annual address. The following officers were elected: President, Colonel C. S. Gzowski; Vice-Presidents, E. P. Hannaford, H. F. Perley, P. A. Peterson; Treasurer, H. Wallis; Secretary, H. T. Bovey; librarian, F. Chadwick. Members of Council: J. D. Burnett, H. Blackwell, F. N. Gisborne, J. Kennedy, G. F. Baillairge, St. G. Boswell, E. Gilpin, M. Murphy, E. Wragge, M. J. Jennings, F. R. F. Brown, B. D. McConnell, J. E. Vanier, and G. A. Keefer.

New England Water-Works Association.—An adjourned meeting was held in Boston, January 16. A paper by William B. Sherman, of Providence, on the subject of Safe Ratio of Pumping Capacity to Maximum Consumption, which was read at the last meeting, was discussed by Messrs. William R. Billings, Dexter Brackett, Frank L. Fuller, A. F. Noyes, J. Herbert Shedd, Mr. Sherman, Edwin Darling, W. M. Hawes, and L. Fred Rice.

Mr. L. F. Rice replied to criticisms that had been made of a paper read by him on the subject of Testing Water-Meters. He defended the methods adopted by the commission of the city of Boston in the tests made several years ago. Mr. E. R. Jones described his experience in the use of water-pipes coated with rosin for the purpose of preventing freezing.

Engineers' Club of Philadelphia.—A regular meeting was held December 15. The Secretary presented, for Mr. J. Milton Titlow, some historical particulars with regard to the old Market Street Bridge, Philadelphia, with an electrotype of the copper plate found at low water level in the middle of the east pier, when it was taken down to be rebuilt above low water for the present iron cantilever bridge.

Mr. F. J. Amweg exhibited photographs of the piers when the rebuilding was being started, and gave some account of the substantial character of the old work, etc.

Mr. Arthur Marichal presented—as a discussion of Professor L. M. Haupt's recent paper on the Plans for the Proposed Improvement of the Bar at the Entrance to the Rio Grande do Sul, Brazil—a description of the Improvements of the Harbor of Libau, Russia.

Professor H. W. Spangler, Mr. Arthur Marichal, and the Author, Mr. J. E. Codman, continued the discussion of Indicator Cards from Compound Engines Showing Expansion through High and Low Pressure Cylinders.

The Secretary presented, for Mr. Robert A. Cummings, a Table of Radii of Curves in Inches, for the *Reference Book*.

The Secretary presented, for Mr. Michael Trump, an illustrated paper on Interlockings, Pittsburgh Yard, Pennsylvania Railroad.

Mr. G. D. Chenoweth presented an illustrated description of the Chenoweth Conduit for Electric Wires.

THE annual meeting was held in Philadelphia, January 12. The Secretary and Treasurer presented his annual report, showing that at the end of 1888 there were a total of 2 honorary, 497 active, and 13 associate members, an increase of about 8 per cent. during the year. The total receipts were $4,746, and the expenditures, $4,032, the net cash assets of the Club being $2,454.

President Joseph M. Wilson called the attention of the Club to prospective efforts to interfere with the excellent organization of the United States Coast and Geodetic Survey.

Professor Arthur Beardsley presented a preamble and resolutions urging upon the Government the great importance and desirability of maintaining both the present status of the Survey and the methods by which its management is selected.

Professor L. M. Haupt seconded these resolutions, and after several members had spoken upon the subject, the preamble and resolutions were adopted.

The retiring President, Mr. Joseph M. Wilson, delivered the annual address, which was devoted to an historical account of bridges from the earliest times on record to the present day. A large number of the more notable constructions, in wood, stone, iron, and steel, were specifically mentioned. Some account was given of the history of the manufacture of iron and steel, and their particular advantages in bridge construction, resulting in their almost universal use for the building of the permanent bridges of the present day. Questions of failures were also considered, and suggestions made in reference to this subject.

The tellers announced that the following officers had been elected : President, William Sellers ; Vice-President, Professor Arthur Beardsley ; Secretary and Treasurer, Howard Murphy ; Directors : T. M. Cleemann, Frederic Graff, Professor L. M. Haupt, Washington Jones, and Joseph M. Wilson.

President-elect William Sellers was unable, on account of illness, to be present, so Vice-President-elect Arthur Beardsley took the chair, with appropriate remarks, and the fiscal year 1889 was duly opened.

Engineers' Club of Cincinnati.—The regular monthly meeting of the Club was held January 2. The Executive Board presented their annual report for the year 1888, which was accepted.

Mr. Whinery, who was connected with their location and construction during a part of the period required in the same, gave the Club an entertaining description of the Inclined Plane and the Broad Gauge Railroad, recently built to the top of Lookout Mountain at Chattanooga. The Inclined Plane presents some peculiar and interesting features from the fact that a large portion of the distance is on a curve. He also gave a short description of the railroad built up Mission Ridge in the same locality. This road, although only about 2¾ miles in length, has very heavy grades and curves, and requires an engine of special construction to operate it.

The peculiar feature of this engine is that it has three vertical cylinders all on one side, engaging by gearing with a horizontal shaft, which in turn connects with the drivers by gearing.

Mr. Whinery exhibited several drawings and photographs to illustrate his subject.

Civil Engineers' Society of St. Paul.—The regular meeting was held January 7.

President Loweth made an address on the best method of increasing the usefulness of the Society.

Mr. W. W. Curtiss read a paper upon the Stand-Pipe for Water-Works.

The following officers were elected for the ensuing year : President, Charles F. Loweth ; Vice-President, S. D. Mason ; Secretary, George L. Wilson ; Treasurer, F. W. McCoy ; Librarian, A. Munster.

Minneapolis Society of Civil Engineers.—At the annual meeting, January 2, the election of officers resulted as follows : President, W. A. Pike ; First Vice-President, G. A. Sublette ; Second Vice-President, F. C. Deterly ; Secretary, W. R. Hoag ; Assistant Secretary and Treasurer, C. A. Huntress ; Librarian, W. W. Redfield. W. A. Pike read a paper on the Quaker Bridge Dam, and W. R. Hoag one on Solar Attachments to Transits.

Iowa Society of Surveyors & Civil Engineers.—This Society was formed at a meeting held in Des Moines, Ia., January 9, by the consolidation of the two organizations previously existing, the Iowa Society of Engineers and the Iowa Society of Surveyors. The headquarters of the Society are to be in Des Moines, where the meetings will be held and a professional library will be collected. The officers of the new Society are as follows :

Ed. Gilchrist, of Keokuk, President ; Seth Dean, Secretary ; F. A. McDonald, Treasurer ; M. Tschirgi, Dubuque, Vice-President ; M. R. Laird and Charles Bennett, Directors.

The technical business of the meeting consisted of a paper on Water-Ways, read by President Gilchrist, and of a general discussion on sewer and drainage pipes.

Engineers' Club of St. Louis.—At the regular meeting of December 5, William F. Schaefer, Louis Simonds, and H. D. Wood were elected members.

Professor J. R. Kinealy's paper on Condensers for Steam-Engines was then read by the Secretary. The resulting economy of fuel was explained, also the principal features of jet and surface condensers. By using condensers the work that an engine would do could be increased ; or, if doing the same work, either the initial pressure could be reduced or the point of cut-off made earlier. Tables showing the results that might be expected at various pressures and cut offs were submitted. This was followed by a long and interesting discussion.

AT the regular meeting of December 19, the result of the election for officers was announced as follows : President, Edward D. Meier ; Vice-President, Francis E. Nipher ; Secretary and Librarian, William H. Bryan ; Treasurer, Charles W. Melcher. Directors, M. L. Holman, James A. Seddon. Member Board of Managers of the Association of Engineering Societies, J. B. Johnson.

Isaac A. Smith then read a paper on Changing the Gauge of the Ohio and Mississippi Railway. This work was done in the spring and summer of 1871. The length of main line from Cincinnati to East St. Louis was 340 miles, branches, 52 ; total, 392. The original gauge of 6 ft. was changed to 4 ft. 9 in.

President Meier called the Club's attention to the proposed monument to Captain Eads. In his opinion it was very desirable that the Engineers' Club of St. Louis should inaugurate a movement in this direction. Colonel Meier and Professor Engler were appointed a committee to look into the feasibility of erecting such a monument.

AT the regular meeting of January 2, several new members were elected :

The Committee on Highway Bridges presented a report favoring the supervision of those structures by a State engineer, but opposing the adoption of standard specifications. This report was adopted as the sense of the Club, and the Committee discharged.

Mr. R. E. McMath called attention to the desirability of collecting and contributing engineering publications for the benefit of the Club's library.

Mr. N. W. Eayrs then read a paper on the Interlocking System of the St. Louis Bridge & Tunnel Railroad. The present system had been in use since 1883. Three stations were operated, one large one in East St. Louis, and two smaller ones in this city. An air-compressing plant was operated at the east pier of the bridge. The compressed air was carried to the three stations, where it was used to operate pumps, which maintained a pressure on a second system of pipe-work, by means of water in the summer, and a solution of chloride of calcium in the winter. A detailed description was given of the workings of the different parts of the system. There was no loss of fluid, except by leakage, which was small.

Mr. Thomas McMath then presented a paper on the Peculiarities of the Citizens' Cable Railway, which was followed by a general discussion.

Engineers' Club of Kansas City.—At the regular meeting of January 7 a committee was appointed to arrange for a banquet. The Secretary was directed to correspond with other associations with reference to transfers of membership. F. C. Gunn was chosen a member, and William B. Knight was chosen to represent the Club on the Board of Managers of the Association of Engineering Societies.

The following officers were declared elected for the ensuing year : President, O. B. Gunn ; Vice-President, W. H. Breit-

haupt; Secretary, Kenneth Allen; Treasurer, F. W. Tuttle; Librarian, Frank Allen; Directors, Wynkoop Kiersted, S. H. Longe.

The retiring President, William B. Knight, read an address. It was advised to make efforts to enlarge the list of associate members, and to add associates and honorary members. The benefit of united action in local societies in bringing about uniform standards, measures, methods of work and legislation was urged. The Club had taken active measures with regard to National Public Works and Bridge Reform, and it was thought much could be accomplished in the conduct of municipal work.

The thanks of the Club were presented to Mr. Knight for his services.

New England Railroad Club.—At the regular meeting in Boston, January 9, a communication was received inviting the members to attend a social meeting of the Central Railroad Club at Buffalo.

The subject for the evening was the Metric System of Weights and Measures. The discussion was opened by Mr. George Richards, and was continued by Messrs. Brooks, Marden, Allen, Coleman, and others, the general weight of opinion among the speakers being in favor of the metric system.

At the close of the discussion resolutions were adopted recommending that the Executive Committee of the Master Car Builders' Association appoint a committee on the Metric System to report at the next annual meeting of the Association.

Western Railway Club.—At the regular meeting in Chicago, January 15, a paper on Anti-Friction Metals was read by Mr. F. F. Bennett, of Chicago, who treated the subject at considerable length. This paper called out a lively discussion, in which interesting facts were given in regard to the wearing qualities of different alloys and the wear of journal brasses. Messrs. Rhodes, Sargent, Barr, Higginson, Sceets, and Townsend took part.

This subject having been closed, a paper on Car Heating was read by Mr. J. H. Setchel, arguing strongly in favor of the steam heating of cars. This was followed by another paper on the same subject by Mr. Johnson, the inventor of the Johnson heater. Mr. C. A. Schroyer spoke at length upon the results obtained with steam heating of trains of the Chicago & Northwestern Railroad during the present season, and a brief discussion on the same point concluded the meeting.

New York Railroad Club.—At the regular meeting, held January 17, the subject of Car Wheels was continued, with special reference to the adoption of a standard wheel and axle for 60,000-lbs. cars.

A paper on this subject was read by Mr. W. T. Hildrup, General Manager of the Harrisburg Car Manufacturing Company, who treated the subject with special reference to the wheels. Another paper on Axles was also read, and this was followed by a general discussion of the subject. The meeting was largely attended.

Northwest Railroad Club.—The organization of this Club was completed at St. Paul, Minn., December 15, when the following officers were elected: President, W. T. Small; Vice-Presidents, W. T. Reed, G. F. Wilson; Secretary, H. P. Robinson; Treasurer, H. L. Preston.

A REGULAR meeting was held in St. Paul, January 5, at which there was a long and interesting discussion on Snow Plows and Flangers, opened by Mr. C. F. Ward, and joined in by nearly all the members present.

NOTES AND NEWS.

The Torpedo Boats of the World.—The following is a brief statement of the strength of the different navies in this class of vessels: Those characterized as deep-sea craft are over 130 ft. in length; first class, from 100 ft. to 130 ft.; second class, less than 100 ft.; and the third class, steam launches and cutters.

England has of deep-sea class 2, first class 49, second class 80, third class 420, and 10 first class in process of construction.

France has of deep-sea 5, first class 20, second class 50, third class 129, and 5 deep-sea and 42 first class in process of construction.

Italy has 2 deep-sea, first class 38, second class 23, third class 150, to be increased to 250 by 1898, and 2 deep-sea and 43 first class in process of construction.

Russia has of deep-sea 2, first class 23, second class 34, third class 138, and 2 deep-sea and 3 first class in course of construction.

Germany has of deep-sea 3, first class 47, second class 48, and 2 deep-sea and 19 first class in process of construction.

Austria has of deep-sea 2, first class 18, second class 8, and 2 deep-sea in course of construction.

Turkey has of first class 19, second class submarine 2, deep-sea 2, and 19 first class in process of construction.

Spain has of deep-sea 6, first class 7, second class 2, and 50 to be built.

Greece has 6 deep-sea and 31 second class, of which 2 are submarines.

Denmark has 5 first class, 11 second class, 5 mining boats, and 14 first class and 14 second class in course of construction.

Norway and Sweden have 12 first class, 6 second class, and 1 mining boat.

Holland has 3 first class and 20 second class.

Portugal has 3 first class, 2 second class, and 3 first class in course of construction.

Japan has 1 armored, 4 first class, 4 second class, and 17 first class in process of construction.

China has of deep-sea 1, first class 1, second class 17, and third class 6.

Brazil has 5 first class and 15 third class.

Argentine Republic has 4 second class.

Chili has 4 second class.

The English colonies have 2 deep-sea, 1 first class, and 3 second class.

With the exception of the torpedo vessel now building at the Herreshoff yard and the *Stiletto*, recently purchased from the same company, the United States possesses no vessel intended wholly for torpedo warfare. This, of course, has no reference to the numerous torpedo launches carried aboard ship and fitted with the ordinary spar appliance, as commonly used at the Newport Torpedo School and on the launches at the Naval Academy.

New Station at Lockport.—One of the handsomest stations on the New York Central is soon to be built at Lockport, N. Y. It will be of Buffalo pressed brick, trimmed with light gray Medina sandstone, with a tower, an antique chimney, and Bangor dark-blue slate roof. The total length will be 128 ft., width, 34 ft. Large handsome porticoes in Mexican style will be placed on three sides. The windows will be dormer with stained glass. The interior walls are of red pressed brick with red mortar, and all woodwork is in white oak.

A gigantic fireplace and mantel will be one of the chief ornaments. It will be of terra-cotta, red slate, and encaustic tile, with andirons, shovel, tongs, poker, and fender guards. The building will be lighted by electricity and gas, and heated by steam.

A German Dynamite Gun.—It is stated in French papers that a dynamite gun made in Germany has been tried at Kiel. This gun has a caliber of 305 mm. (12 in.), and is 22.86 meters (75 ft.) long.

The description given is not very definite, and there may be some mistake about the length. The target at which the gun was fired was an old hulk, placed at a distance of 1,930 meters (6,330 ft.). The first shot was made with an unloaded shell to get the range; the second and third shots were each with a shell loaded with 598 lbs. of nitro-gelatine, and completed the destruction of the target.

New Bridge at Cincinnati.—On December 25 last the first train passed over the new Chesapeake & Ohio Bridge over the Ohio River, at Cincinnati.

The bridge is 5,320 ft. long, and, including all approaches, 17,000 ft. in length. It has two spans of 490 ft. each, and one of 550 ft. It is double-tracked for railroad trains, has wagon and street-car ways 11½ ft. wide, and foot passages 5 ft. wide.

It is calculated to bear the following strain: Two consolidation engines and tenders, with 14 ft. base, weighing each 104,000 lbs., coupled, on each track, followed by a uniform weight of 2,500 lbs. per lineal foot for the entire length of the structure; the concentrated weight of 30,000 lbs. on 10 ft. of each wagon-way, followed by a uniform weight for the whole length of 80 lbs. to the square foot, or about 900 lbs. to the lineal foot; on each foot-way 500 lbs. per lineal foot from end to end. A wind pressure of 30 lbs. to the square foot on the entire surface, including cars, has been provided for.

The total cost of the structure, including real estate, was a little over $5,000,000. Ground was broken for the first caisson in June, 1887, and work in iron was begun in March, 1888.

The bridge was built by the Phœnix Bridge Company, and, according to the *Cincinnati Gazette*, from which this account is condensed, the other contractors were, for the pneumatic work, Sooysmith & Co., of New York; and for the masonry, Mason,

Hodge & Co., Frankfort, Ky., and D. Shanahan, Louisville, Ky.

Superintendent Epes Randolph has had general supervision for the constructing company, with Captain A. H. Sawyer as Resident Engineer. For the bridge company's work Engineer J. S. Deans has been responsible, with General Foreman A. B. Millekin as First Assistant.

Friction of Locomotive Slide Valves.—At a recent meeting of the English Institution of Civil Engineers, a paper on this subject was read by Mr. J. A. F. Aspinall, in which he stated that only scanty data existed as to the friction of slide valves, and that the few experiments which had been made were not of a very satisfactory character. Hence he was led to design an apparatus for graphically recording the force required to move slide valves during the whole of their travel. The apparatus consisted of a small hydraulic cylinder and piston, which was made to form part of the valve link. An ordinary steam-engine indicator was screwed on to one end of this cylinder, and an air valve was placed on the other. For pulling, the indicator was on one end of the hydraulic cylinder. For pushing, it was placed on the other end. A second indicator on the valve-chest gave a simultaneous diagram of the pressures on the back of the valve. The pressure on one side of the hydraulic piston being atmospheric pressure, that shown by the indicator at the other end was the force required to move the slide valve, less any friction of the apparatus. The Author described the experiments made to determine the friction. The results showed that the relation between the pull or the push on the valve, and the pressures recorded by the indicator, could be expressed by a simple linear equation:

$$L_1 = 5.6 + 11.26\ L,$$

where L_1 was the pressure due to the force required to move the valve, and L the pressure shown by the indicator. The results of experiments with the apparatus on an ordinary brass valve, a brass Allen valve, and a cast-iron valve, were then given, both with the link in full forward gear and with the link notched up. A small excess of the pushing pressures over the pulling pressures was shown to be due to the steam pressure on the back end of the spindle. Samples of the diagrams and calculations were submitted. As the valve resistance was not uniform throughout the stroke, the causes of variation were discussed. These were the variation of pressure on the back of the valve, the variation of pressure on the face of the valve, the variation of pressure in the exhaust space, and the inertia of the parts in motion. As the most convenient measure of the valve resistance, the Author took, not the mean resistance of the valve, but the resistance at midstroke, and he compared his results with the few experiments previously made. The Author's results made the valve resistance considerably less than it had been supposed from previous experiments. He found the resistance of a valve in motion, with 127 lbs. to 139 lbs. pressure on the back, to range from 982 lbs. to 1,321 lbs. The valve was 16½ in. by 10 in. Taking one case, the total load on the back of the valve was 22,110 lbs.; the relieving pressure on one steam port, 1,800 lbs.; the relief due to steam in the valve passage, 980 lbs.; and the relief pressure on the exhaust area, zero. Hence the resultant load was 19,330 lbs. The force necessary to move the valve was 1,321 lbs.; the co-efficient of friction was therefore 0.068. Similar calculations for two other valves gave co-efficients of friction of 0.054 and 0.051. The lowness of the co-efficient of friction was remarkable, especially as the temperature of the surfaces must be about 350° Fahrenheit. The Author calculated the percentage of power lost in slide valve friction at 1.34 to 2.26.

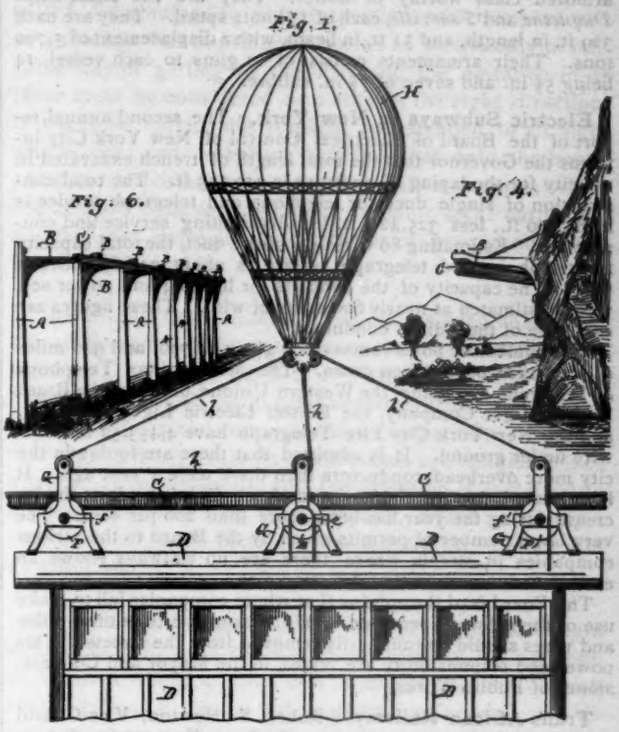
A Reversed Elevated Railroad—The accompanying illustration shows what may be called one of the curiosities of the Patent Office, a device in which the inventor, with a sublime disregard of natural laws, proposes to dispense with gravity as a means of securing adhesion and, instead of running his train *upon* the track, to run it *underneath*, employing outside means to hold his car or locomotive up to the track.

The patent, which is No. 392,632, is granted to Robert T. Oney, of Charleston, W. Va., and is for an improvement in elevated railroads, which consists in suspending the car by means of a balloon, using the track only for purposes of traction and as a guide to the car.

The invention consists of a peculiar construction and arrangement of a locomotive having drive and guide-wheels held firmly against the traction surface of an overhead center single rail by the lifting force of an aerostat.

In the accompanying drawing *A A* are ordinary posts or standards, from which brackets, *B B*, project horizontally, and to the under surface of these brackets an inverted rail, *C*, is attached. A motor-car, *D*, arranged in any familiar manner, to be operated by steam, caloric, electricity, or any other suitable force, runs below the rail, having a drive-wheel, *E*, and guide-wheels, *F F*, to keep the wheels to the rail. From the

Fig. 1.



axles *e* and *f' f'* of the several wheels coupling-rods, *G G*, rise into the air. To the upper ends of these rods an aerostat, *H*, is flexibly attached by ropes, chains or other equivalent attachments, *h h*, which can be payed out or hauled in as wind-currents or other circumstances may determine.

The French Navy.—From 1873 to the present time the growth of the French Navy has been as rapid as it has been steady; and the progress made in dockyard construction and the establishment of naval ports has been fully commensurate with the developments of the day.

Notwithstanding their impoverished condition at the close of the war, the French managed to obtain money, and began, at enormous expense, the first vessels of the navy that they to-day possess; and their success is due to the fact that they bent all their energies upon the building of the best armor-clad fighting ships and of the fastest and most powerful cruisers.

The last Parliamentary returns, dated June, 1888, showed that the French have 25 modern fighting ships, against 17 in the British service, and the fact that two-thirds of the 25 modern French fighting ships could singly blow any of the British Mersey class out of the water renders the great body of the British naval establishments of little importance in the event of war with France. The importance of the French Navy becomes even more evident when we consider that France is not dependent on her colonies for the supplies necessary to the preservation of her people. In the event of war she can draw on neighboring foreign territory for such commodities as her own vast resources fail to yield.

The following is a classified list of the most important of the vessels in the active list of the French Navy:

Iron-clads	18
Cruisers (iron-clads)	10
Guardships (iron-clads)	11
Gunboats (iron-clads)	4
First-class cruisers (protected class)	9
Second-class cruisers (protected class)	15
Third-class cruisers (protected class)	15
Torpedo cruisers (protected)	1
Sea-going torpedo boats	9
Gunboats (protected)	18
Steam sloops (protected)	12
Training ships and gunnery vessels	40

The *Admiral Baudin*, the largest vessel in the list, has a maximum speed of 15 knots an hour, a displacement of 11,380 tons, has 22 inch of armor, and carries three 14¾ in. and twelve 5½ in. guns. This vessel is considered by many a more handy craft than the heavy *König Wilhelm* of the German Navy, but possesses many disadvantages by reason of her great tonnage.

Other powerful vessels are the *Duperre*, the *Indomitable*, the *Hoche*, and the *Courbet*.

Aside from the iron-clad list there are two vessels in the unarmored class worthy of notice. They are the sister-ships *Duquesne* and *Tourville*, each of 17 knots speed. They are each 329 ft. in length, and 51 ft. in beam, with a displacement of 5,700 tons. Their armaments consist of 21 guns to each vessel, 14 being 5½ in. and seven of 7½ in. calibre.

Electric Subways in New York.—The second annual report of the Board of Electrical Control of New York City informs the Governor that the total length of trench excavated in the city for the laying of subways is 240,155 ft. The total construction of single duct for telephone and telegraph service is 2,287,880 ft., less 325,429 ft. for distributing service and connections. Estimating 80 wires per single duct, the total capacity for telephone and telegraph service is about 34,665 miles of wire. The capacity of the conduits for lighting and power service is estimated at nearly 600 miles of wire. These figures are exclusive of the Edison conduits.

The number of poles removed is given as 776, and 946 miles of wire have been taken down. The Metropolitan Telephone & Telegraph Company, the Western Union Company, the Brush Electric Light Company, the Edison Electric Light Company, and the New York City Fire Telegraph have 4,453.52 miles of wire under ground. It is admitted that there are to-day in the city more overhead conductors than there were a year ago. It is intimated that in the business of arc lighting alone the increase during the year has been more than 200 per cent. The very large number of permits given by the Board to the various companies in streets where there are no subways shows an enormous increase in that direction also.

The Board is of the opinion that where companies fail to make use of the subways provided within reasonable time their poles and wires should be summarily removed from the streets. This power and responsibility are vested in the Mayor and Commissioner of Public Works.

Trans-African Railway.—Robert S. Newton, Vice-Consul at St. Paul de Loando, reports to the State Department that on October 31 the first section, 45 kilometers, of the Royal Trans-African Railway, from Loando to Ambaca, was opened to the public. Mr. Newton says:

"The line passes through districts alternating between large tracts of prairie, wooded hills, and fertile valleys watered by rivers and streams. The country about the margins of these rivers is already cultivated, both by natives and Europeans, and produces fruit in abundance, vegetables, sweet potatoes, and large quantities of sugar-cane. With the facilities now offered by the railroad for the carriage of machinery and materials for building purposes there is every prospect in the near future of the large tracts of uncultivated land being made to yield their quota of agricultural produce.

"There are proofs at hand of the utility of this enterprise to the commercial community generally and to the agriculturist in the interior.

"Large quantities of coffee are stored in the district of Cazengo owing to the want of carriers. Thus the produce is tied up to the serious loss of both agriculturists and merchants here. The coffee market in Europe is much better now than it has been for several months, but the merchants here are simply debarred from taking advantage of it, as they cannot get the coffee off the plantations, and in the mean time they not only lose a good market but interest is running on the capital so locked up. If the railroad were completed to this district all such risks would be completely done away with. If, now that they have commenced, they will go ahead and carry the line to completion as quickly as possible, the prosperity of the province would be assured. They have, however, a rather difficult country to go through before they reach Ambaca, and there is not much prospect of the line being completed within three years."

Cast-Iron Lighthouse Tower.—The accompanying illustration shows an elevation and section of a cast-iron lighthouse tower erected at Gibb's Hill, Bermuda; the lantern, which rests on the platform at the top, is not shown.

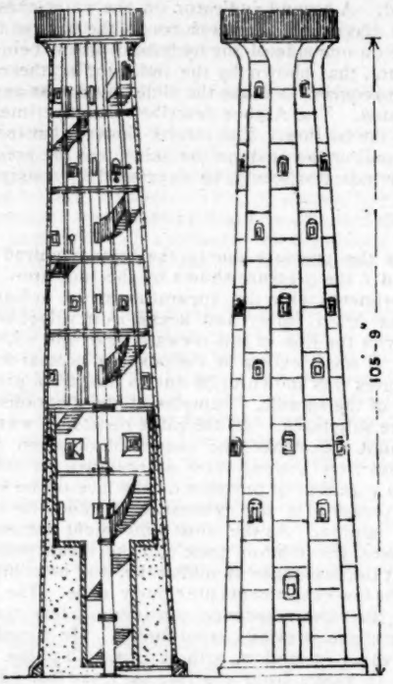
The form of this tower, the base of which is 245 ft. above the level of the sea, is that of a strong conoidal figure 105 ft. 9 in. in height, terminated at the top by an inverted conoidal figure 4 ft. high instead of a capital.

The external shell of the tower is constructed of 135 concentric cast-iron plates, including those for the doorway. These plates vary in thickness from 1 in. at the base to about ¾ in. at the top; they have cast-iron flanges on the inside 4 in. broad, including the thickness of the plate, and are further strengthened at intervals of 12 in. by angular feathers ½ in. thick. Holes are drilled in all the vertical and horizontal flanges 6 in. apart, and the plates are united to form the tower by square-headed screw-bolts ¾ in. in diameter with nuts and washers. In the center of the tower there is a hollow column of cast iron 18 in. in diameter in the inside, the thickness of the metal being ¾ in. for supporting the optical arrangements and in which the weight of the revolving apparatus descends.

This column was cast in nine lengths, each terminating with circular flanges to which the floor-plates are bolted. At a height of 2 ft. above each floor there is an opening into this hollow column 26 in. high and 15 in. wide to which wooden doors are fitted. It is used during the day for passing stores up and down, and it likewise contains the waste-water-pipe.

About 20 ft. of the lower part of the tower is filled in with concrete, leaving a well in the middle about 8 ft. in diameter faced with brick-work. There are seven floors, exclusive of the lantern floor or gallery, each 12 ft. in height. The first and second floors are cased with brick-work and serve as oil and store rooms; the five upper floors are lined with sheet iron, No. 16 gauge, disposed in panels, with oak pilasters, cornices, and skirtings.

On the first floor there is a cast-iron curb 10 in. wide and 1



in. thick, on which a cast-iron floor-plate ¾ in. thick is fixed by bolts ⅞ in. in diameter. The inner edges of this, and of all the other floor-plates in the tower, are bolted between the flanges of the corresponding parts of the hollow column by ¾-in. bolts, nuts, and washers.

The second floor consists of 10 radiating cast-iron plates ¾ in. thick, extending from the brick-work to the hollow column; these plates have flanges on their under side and are held together by ⅞-in. bolts at intervals of 6 in. The other floors are similarly constructed, but the outer edges rest on the upper flanges of the shell, being bolted to it by the same bolts which connect the flanges of the plates of the shell. There are five windows in each floor, one in the center of every alternate plate in the circle; these windows are 18 in. square, and are fitted with strong wooden posts opening outward, in which a plate of polished plate glass, 9 × 5 in., is fixed for giving light when the port is closed. There is also a window of the same dimensions in the circular wall for admitting light to the staircase, making 36 windows in all.

The staircase consists of two wrought-iron stringers 1⅛ in. square, the rises and supports being ⅝ in. thick with oak treads 1½ in. thick. To each step there is an iron baluster ⅞ in. in diameter, on the top of which is fitted a wrought-iron hand-rail 1⅛ in. wide and ⅝ in. thick. A wrought-iron ring 5 in. wide and ⅝ in. thick, made in four pieces, is attached to the under side of the eighth floor by screw-bolts ¾ in. in diameter, to which the lantern and light-room are bolted. The height from the gallery to the center of the light is 11 ft., and from the center of the light to the top of the vane is 17 ft., making the total height of lighthouse 378 ft. 9 in. above level of high-water. The light can be seen from the deck of a vessel at a distance of 26 or 27 miles. The total cost, including the lighting apparatus, was about $38,000.